ELECTRICITY NETWORK REGULATION - PRACTICAL IMPLEMENTATION IN THE NORDIC COUNTRIES

Kaisa Kinnunen[1]

Abstract

The Nordic countries already have a long experience in the liberalisation of the electricity sector. In each country there is a specific regulatory authority that supervises the monopoly part of the sector, the distribution and transmission of electric energy. The regulatory systems usually address the issue of preventing monopoly rent and often inducing efficiency improvements.

In all of the Nordic countries the electricity network regulatory schemes address the efficiency problem although the schemes differ between the countries. For example Denmark and Norway apply ex ante regulation whereas Finland and Sweden have ex post systems. In the paper the regulatory systems in these countries are described. The advantages and disadvantages of these real-life regulation systems will be analysed in more detail. Finally some judgements of the success of the regulatory schemes based on cost and price information of the companies are made. The preliminary results show that there exist large possibilities for cost saving in the Nordic electricity sector.

1 Introduction

The electricity sector has typically been regulated in order to prevent natural monopolies abusing their market power. After the liberalisation of this sector regulation is focused on the distribution and transmission of electricity while production and sales have become competitive business sectors. This paper gives a brief overview of some regulatory approaches and evaluates their practicability presenting the Nordic countries as an example.

[1] bremer energie institut, kinnunen@bei.uni-bremen.de.

The purpose of regulation is to create conditions similar to competition in such part of the market where full competition fails. Regulation is introduced to secure public interest. This means on the one hand the exclusion of prices that significantly exceed those of competitive industry and on the other the prevention of excessively low prices hampering competition that are possible due to cross-subsidisation in a vertically integrated company.

The main problem of the theoretical regulation methods is asymmetric information between the regulator and the regulated utility. The regulator has always incomplete information about the true cost of the firm. It is also difficult to associate the non-product-specific cost with the right cost carriers, which poses an additional information problem of regulation. Another problem is inefficiency and thus the different regulation methods can be classified based on their approach to efficiency improvements.

In practice perfect competition without cost is impossible. All theories face limitation in their practical implementation. There is no "right model" and that is why the models must be adjusted to the real-life situation. In all of the Nordic countries the electricity network regulatory schemes address the efficiency problem although the schemes differ between the countries. For example Denmark and Norway apply ex ante regulation whereas Finland and Sweden have ex post systems. Different theoretical regulation methods are overviewed in chapter two and in chapter three the regulatory systems in these countries are described. In chapter four the advantages and disadvantages of these real-life regulation systems will be analysed in more detail. Chapter five focuses on examining network prices in these countries based on efficiency studies.

2 Regulation Methods

Baumol (1995, p. 255) defines the purpose of economic regulation as "protection of the public from the detrimental consequences of inadequacies of competition". This can be done by creating conditions similar to competition in such part of the market where full competition fails and the regulator acts as a substitute to market forces. The competitive market is considered to be a value in itself and therefore a commonly acknowledged economic principle is that in a fully competitive markets there should not be any public intervention. However, when markets fail, the regulation authority should intervene, but only as little as possible letting the firm choose its operational policy freely after the introduction of necessary regulation measures. This *public interest theory* assumes

that regulation can take place without any costs and that the regulator has got no own agenda and is able to correct the market failure perfectly. (Baumol, 1995, p. 255; Knieps, 2001, p. 80.)

It has been recognised that the basic problem of regulation is asymmetric information between the regulatory authority and the regulated utility. It has also been realised that the regulator can influence firms decisions about *efficiency improvements*. The principal-agent theory is based on an idea that the regulated utilities must be granted a profit so that they have an incentive to act efficiently. This profit is limited by the regulation method.

The normative regulation theories can be roughly divided into *structural regulation* and *price regulation*. In the case of structural regulation the regulator aims to organise the market structure so that there prevails no efficiency losses or possibilities to misuse the monopoly power. With price regulation the prices or the revenue of the utilities are regulated. The optimal markets are created as a reaction to price setting according to the regulatory rules. Both of these mechanisms are often used at the same time.

Regulation is mainly designed to prevent monopoly rents or efficiency losses due to the failure of competition. The normative public interest theory is based on traditional *welfare economics*, that assumes that the maximisation of consumer and producer rent can be reached without causing incentive biases in the operations of regulated utilities. Thus, the regulator tries to find an optimal solution that would *maximise the welfare of the society*. However, the regulatory constraint does not solve the problem that the monopoly tries to maximise its profit - an aim that does not usually coincide with the interest of the society. The regulatory constraint only helps at reducing the problem.

In *price-regulation* two main approaches can be identified depending on the basis how they are built. Historically the most commonly used regulation method has been *bottom-up* regulation meaning that the regulatory authority bases its decisions about a suitable price on the cost information of the regulated utility (cost-based methods, like the rate-of-return regulation for example). In *top-down* regulation a maximum price or revenue, a so-called price-cap or revenue-cap, is set that the regulated company has to accept. These maximum cap methods belong to *incentive based* methods that aim in avoiding the problem of lack of efficiency.

The cost based regulation methods belong to the price regulation but they mostly fail because they do not produce a reliable regulation result because of asymmetric information. In addition, they do not produce a socially efficient solution because the incentive for efficiency improvements is missing. With the incentive based price- or revenue-cap methods the regulator tries to solve this problem by setting an upper limit to the price (revenue) according to the cost of the utility with a longer regulatory period. During this period the firm is allowed to keep all profit that it can extract through cost reductions. The problem is that the firm might have the incentive to increase its cost for the time of the new review in order to prevent the sinking of the price cap. In this case the efficiency improvement between the regulatory reviews would not benefit the customers at all.

A very often discussed incentive regulation method is the *yardstick competition*. It avoids the problem of asymmetric information through a *benchmark*. The regulator compares all firms in the sector and determines based on comparison which kind of performance the utility would be able to produce. This method creates an incentive to cost reductions and efficiency improvements because the firm gains when it improves its performance (i.e. decreases its cost) and the other firms in the markets do not. Respectively, it looses when the other utilities reduce their cost and it does not. Problems can arise if the firms are very heterogeneous and therefore there is no realistic benchmark for the regulated companies. Theoretically, companies can form a collusion which would falsify the result of the regulation.

Principally regulation aims to create prices that

- are in some degree cost oriented (they should cover the cost of the network activity)
- are non-discriminating and fair
- have a signal and steering function
- are practical, simple and transparent.

Which ever model is chosen, it should not be subject to short run changes in the regulatory policy, which means that the possible regime should be sustainable regardless whether it is based on structural or price regulation or whether its focus is on preventing profit or creating an incentive to cost reduction.

Finally, the regulation methods can be divided into *ex ante* and *ex post* regulation methods. Ex ante regulation focuses on setting regulatory frames at the beginning of the period, ex post regulation evaluates the performance of the firms in the sector at the end of the period. Sometimes the ex ante

methods are called tight-handed regulation and the ex post methods light-handed based on the freedom they leave the regulated utilities.

3 Regulation of the Electricity Distribution Networks in the Nordic Countries

3.1 Overview

The Nordic countries have taken a leading role in the liberalisation of the electricity markets in Europe. In Norway, the liberalisation of the electricity sector began already in 1991 and the full market access for all end-user groups was established in 1995. Encouraged by the good experiences of Norway, Sweden and Finland followed with liberalisation of their electricity sector in 1996 and 1997 respectively when the markets were opened to all consumers. In Sweden the liberalisation has lead to significant changes in the structure of ownership of the branch into more concentration and international ownership. Denmark began with the gradual liberalisation of the electricity market in 1999. The market is expected to be fully opened by 1.1.2003. The transmission and distribution tariffs and other terms of business operations are set under supervision in all of the Nordic countries.

In these countries the market opening is based on a so-called *regulated third-party access*. It means that the networks are opened to third parties and that the network utilities are regulated by an authorised institution.[2] In each country there is a specific institution who is responsible for setting rules and monitoring the electricity sector. In Norway this institution is a ministerial agency whereas in the other countries there are independent regulatory authorities who share regulatory responsibilities in the markets with the ministries. Electricity production in all of these countries is subject to an authorisation. (IEA, 2001, p.33.)

The structure of ownership of the electric utilities differ from privately owned to municipal distribution utilities. A planned privatisation of electric utilities has not taken place in any of these countries. However, in countries where vertical integration is allowed large generation companies buy other generation and network utilities which increases concentration in the sector. The corporate mergers also take place across the border. The concentration in the generation sector is rather high in the Nordic countries.

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[2] Another form of market opening is a *negotiated network access* which is implemented for example in Germany.

The driving force behind the new energy market legislation in these countries was the need for cost savings and for more efficient use of energy resources. Thus, each country has built an incentive to efficiency improvements in its regulatory scheme. The legislation in all of these countries requires that there must be a separation of accounts of network operations and other business activities. Sweden is an exception among these countries because the Swedish legislation requires a total separation of electric utilities' activities into distribution and transmission in one part and into generation and trade in the other part. This unbundling is required in order to avoid cross subsidisation of the competitive part of the electricity sector through the network operations.

The Finnish, Norwegian and Swedish markets (and in an increasing amount also the Danish) are very much integrated through the Scandinavian transmission network organisation, NORDEL and the Nordic Power Exchange, the Nordpool. There is therefore a need for close co-operation between the national grids as well as between the regulatory authorities. Nevertheless the implemented regulatory systems differ quite significantly.

3.2 Norway

The network regulation in Norway was based on rate-of-return regulation during the years 1992-1996. However, the problems of this method were soon recognised. The main problems were inefficiency caused by the full recovery of the firms' cost and the lack of incentive to restructure the industry. Therefore, it was decided to renew the regulatory system to realise possibilities for efficiency improvements.

The Norwegian, like also the Danish regulatory system, is an ex ante regulation method based on incentive regulation with the help of income frames. It is a revenue cap system similar to the price cap method. There is an upper and lower limit set at the beginning of period to the revenue for each individual firm each year. In Norway the regulatory system sets income frames for the period of five years. Income frames will be revised yearly. The frames are set so that the firms can cover their operative cost, depreciation and the return on capital for *efficient operations*. The firm's profit is the difference between the allowed revenue and the cost of the firm, which should give an incentive to reduce cost. (EWI, 2001, p. 27; Grasto, 1997, pp. 7-8; Lavaste, 2001, p. 36.)

In the Norwegian system the total cost of the network is considered to consist of operation and maintenance, capital cost like depreciation and return on invested capital, network losses and profit

tax of 28 %. Also the cost from having to purchase transmission services from other networks is added to the permitted income. All cost external to network activities is deducted to derive net cost, which should be covered by the permitted income. The permitted income also includes a base return rate of 8,3 %. This base return rate is calculated based on a medium-term government bond interest rate with a 2 % risk premium. Therefore, if the network owner wants to increase his profit he has to reduce his actual cost. Similarly, cost increases will reduce the profit. However, there is an absolute upper limit set to the permitted profit, which amounts to 15,3 % i.e. the profit on average should not exceed this percentage during 1997-2001. Also an absolute minimum of 1,3 % is defined so that no network utility could run into deficit. (Grasto, 1997, pp. 8-9.)

The total permitted income is thus the permitted income of the owner's network added with the cost that are incurred by transmission services carried out by external networks. If the actual income from tariffs exceeds the permitted income the network utility has to pay back the extra profit (so-called *windfall profit*) with interest to the customers in the second year from the relevant financial year. Similarly, if the actual income is lower than the permitted income the firm is allowed to raise its tariffs in the second year calculated from the relevant year. The permitted income will be reviewed every year. A full review will be made every five years. The annual correction is the permitted income in year 2 equals the permitted income in year 1 times the change of the customer price index in year 2 (forecast) multiplied with the efficiency requirement times the half of the amount of change of the distributed electricity in year 2 (forecast). The last term should give the network owner compensation for the cost of new investments as well as a reward for a better utilisation of the existing network. (Grasto, 1997, pp. 11-12.)

The efficiency requirement correction is divided into two parts: a general correction and an individual correction. The general part is the same for every utility (1,5 %) and it is determined based on a study made by Førsund and Kittelsen (1998, p. 222) according to which the general productivity improvement of the Norwegian network utilities is 1.5 – 2 %. Norway determines the individual productivity requirements for the network utilities with a so-called Data Envelopment Analysis (DEA–method), which is based on relative comparison of the network utilities based on input and output information. The distribution network utilities have been subject to individual efficiency correction since 1998 and the regional and the national network utilities since 1999. (Lavaste, 2001, pp. 34-35.)

The individual part of efficiency requirement was fixed for 1999-2001 and was determined based on cost efficiency calculated with the DEA using personal work years (amount), the amount of losses (MWh) and the monetary value of capital (lines, cables, transformers etc.) as inputs and the amount of customers, distributed electricity (MWh), length of lines (km) and length of sea cables (km) as outputs. By defining the efficiency requirement for each company the efficiency of every utility was considered of being at least 70 % of maximum. The efficiency requirement was set at maximum 3 % a year which responds to circa 38 % of the potential of total efficiency improvement in four years. The average required individual efficiency improvement was therefore 1,4 % a year.[3]

For the next regulation period 2002-2006 the regulatory system was improved by taking a factor measuring quality into account. Every network utility was determined an individual efficiency aim for quality. If this is not reached the allowed revenue will be reduced, if it is exceeded the utilities will be allowed to have a higher revenue than set at the beginning of the period. In other respects the system is pretty much like during the first incentive regulation period. As a basis for the determination of the revenue cap the average operational cost of the years 1996-1999 and the depreciation of 1999 were used. The return on capital will be determined yearly unlike during the first phase. The risk premium is 2 % and the production improvement requirement is composed from the general 1,5 % and the individual rate. The individual efficiency improvement rates were determined with a new benchmark and got the values between 0 % and 5,2 %. The effective profit was increased to maximum of 20 % (from 15 %) because according to the network utilities the revenue cap of the first period had not adjusted to demand increase adequately. (Wild and Vaterlaus, 2002, pp. 11-12.)

3.3 Denmark

The Danish regulatory system is also an income frame system where the frames are set for the period of four years. According to the regulatory scheme the operative cost should cover the operation and maintenance cost of the network. There is a general requirement for efficiency improvement of 3 % set by the Ministry of Energy and an individual efficiency improvement requirement set by the Energitilsynet for the operative cost and depreciation. An individual efficiency number for each utility is the corrected labour cost per the volume of the network for the urban and countryside utility based on customer density of the distribution area. The labour cost include the direct and indirect work cost as well as depreciation of capital. The volume of the

[3] {(100 - 70) % * 38 %} / 4 = 3 %

network is composed of the sum of air lines, cables, electric stations, transformers and the customers multiplied with an equivalent calculation unit. They are determined based on average labour cost of different components. The basic unit is one kilometre of 0,4 kV cable, which equals to 1 calculation unit. The efficiency improvement requirement is focused only on utilities whose efficiency number relative to the most efficient utility is below 80 %. They are required to reach the 80 % efficiency level during 2000-2003 for cost and for depreciation for 2002-2003. The largest yearly improvement requirement is 10 % of the cost. (Energitilsynet, 2001a; Energitilsynet, 2001b, p. 1; Lavaste, 2001, pp. 36-37.)

The return on capital is supposed to recover the cost of upgrading the network and the interests of own and external financing. The allowed rate of return is a sum of rate of return of obligations, supplements for the finance of extension investments and for acquisition of means of exchange as well as for the price increase of the investment cost. The higher the rate of own capital finance the smaller is the allowed rate of return. However, it is never smaller than 1. After the regulatory period it will be determined for each year whether the cost or the income have exceeded or remained under the set limits. If the utility succeeds in saving, it may keep the gained utility until 5 % of the income frames. (Lavaste, 2001, p. 37.)

The Danish efficiency improvement scheme shows that the sum of the individual efficiency improvements of operational cost can be at maximum 20 %. The individual potential for efficiency improvements for 2002 and 2003 will be divided by two to get the yearly individual improvement potential. At maximum the total sum of the improvements of periods is 20 %. Thus, the sum of the individual efficiency improvement requirement may be 14 % at maximum because of the yearly 3 % general requirement. For the year 2002 the Energitilsynet has set a cap of 4,5 % for the individual efficiency requirement and for 2003 a cap of 9,5 %. (Energitilsynet 2001a.)

3.4 Finland

The idea of the regulation method used in Finland is based on the assumption that the distribution and transmission companies are principally functioning according to the Electricity Market Act. Therefore, an ex ante regulation of distribution pricing is not necessary. The Finnish system is thus based on ex post supervision, which is a significant feature of the system. The supervisor cannot pre-impose service prices, pricing principles, forms of service or any other similar matters on the supervised companies. It just makes a judgement whether or not the pricing has been lawful. It can require the firm to improve its pricing if it considers the pricing to have been unreasonable. (EMA,

2001, p. 27.) This is the main difference of the Finnish system from the regulation schemes implemented in Norway and Denmark.

The supervision of network prices is built on the principle that pricing corresponds to operating cost. The present cost level of the firm is compared with the real cost that the company would be capable to achieve if it functioned efficiently. This is determined by multiplying the historical cost of the firm by an individual efficiency number which is calculated based on physical information of the network infrastructure and operating environment with the DEA-method like in Norway. Based on cost efficiency it is determined whether the cost have been reasonable. If the cost is not efficient, the prices should be corrected. The system has characteristics of the yardstick competition, because in order to create an incentive to efficiency improvement and cost reductions the firms efficiency is measured based on a system, where the electricity distributing firms are compared with each other. The efficiencies will be applied in the evaluations concerning the reasonableness of the pricing of distribution from the year 2002. (Korhonen et al., 2000; Lavaste, 2001, p. 52.)

If the efficiency exceeds 90 % relative to the most efficient firm, the firms reasonable cost is considered to be higher than the actual cost and the firm is granted an incentive bonus, which means that the firm is allowed to profit from its activities over the reasonable level with a corresponding sum. If the efficiency is exactly 90 %, the firm's reasonable cost equal actual cost and no more measures result. If the efficiency is less than 90 %, the firm's reasonable operating cost would be lower than its actual operating cost. It can then be argued that the firm has collected too much cost from its activities and the firm is required to improve its efficiency. A 70 % efficiency means that the company should reduce its input use by 20 % in order to be considered efficient. (Lavaste, 2001, pp. 50-52.)

The Finnish system is formed from two aspects: pricing must on the one hand allow the revenue to cover the reasonable cost of network maintenance, operation and construction and on the other to yield a reasonable return on the invested capital so that the firm is able to operate and stay in the markets. By defining a reasonable return on capital the low risk content as well as the financing cost of investments and the long service life of equipment are taken into account. It is though that the value of the capital base should be evaluated based on the current value of the distribution network. (EMA, 2001, p. 25.)

For the measurement of the value of the invested capital a method is used where the balance sheet value of the fixed assets invested in the network is adjusted consistently with a separate assessment of the value of the network i.e. the current value. A reasonable return on invested capital is determined with a WACC (Weighted Average Cost of Capital) model. The definition for an allowable return on equity can be estimated as the governments 5-year bond interest rate added by a risk premium of 1,5 per cent. The monopoly functions are considered to be more risk-free than many other forms of business and therefore it is considered that the required returns should stay equivalently small. The return on the external capital is defined using the average lending rate of the total loan stock of the Finnish companies. The acceptable return is thus defined as the weighted average of the rate of return on own and external capital. The used weights are the shares of own and external capital accordingly. Finally, the depreciation from fixed assets should be based on the real investments of the companies (as opposite of monetary investments). (EMA, 2001, p. 26; EMA, 2000, pp. 30-31.) This model can be criticised because the companies find out the acceptable rate of return for external capital only afterwards. Therefore, they can not take it into consideration in their pricing and planning of operations.

Thus, the decisions of the EMA have two aspects: the evaluation of reasonableness of cost and of return on capital. The decisions in respect of these aspects will be divided into four different groups according to the need of improvement. If the cost and the return on equity are both reasonable there is no need for improvement. If only the return on equity is too high, the firm is allowed to keep the extra revenue in height of its incentive bonus but has to correct its pricing by that part of extra revenue that exceeds the incentive bonus. In a case when the cost is unreasonable but the return on equity is reasonable there are two possibilities. The EMA can require that the firm corrects its cost structure, but is still allowed to keep the return on equity. The other possibility is that the extra cost of the firm is compensated with the lower return on equity and the firm could be required to take some corrective actions only if the difference is positive. The fourth case is simple; if both the return on equity and the cost are unreasonable, the firm can be required take corrective measures. These should be taken within three months after the decision has been let known to the firm. (Lavaste, 2001, p. 53.)

The Finnish regulatory framework in a nutshell:

- No ongoing price regulation.
- Tariffs set independently by the firms.
- Case-by-case ex post price supervision.

- Investigation of prices may start through a complaint or on the initiative of the EMA.

3.5 Sweden

Like Finland, also Sweden uses an *ex post regulation* method. This means that the prices are monitored individually for each utility after each period. It was considered that the electric utilities should be able to guide the development of the sector themselves. The used method is based on "a factor price index" meaning that the development of the network tariffs should follow the general development of input prices. In addition, a general requirement for efficiency improvement ("a rationalisation factor") should be taken into account. However, this method has been considered inadequate and therefore the regulatory authority has suggested a new "*network utility model*" (Nättnyttomodellen) in order to improve the general efficiency of companies. It is based on the measurement of the difference between the utility the customer experiences and the revenue received by the company. (SNEA, 2001, SNEA, 2002a, SNEA, 2002b, p. 11; Lavaste, 2001, p. 31.)

Most models developed to increase efficiency try to determine whether the resources invested in the network activities are allocated efficiently. In the network utility model the approach is different. The method does not regard at all the efficiency of the used resources. Instead the network company is allowed to have as much revenue as it offers utility or value to its customers. The network utility (customer utility) is *network performance* multiplied with a *quality surplus*. To derive the network performance a fictive network is framed. It is formed of high and low voltage lines, the frontier points between regional and local network, electric stations and the customers point of connection.

The cost of this fictive network equal the network performance. In the calculation the used cost is what has considered to be a standard cost in the sector, like for example depreciation is calculated based on 30 years life time and the capital productivity is 4 % added with 2 % risk premium. The quality surplus is calculated based on the cost of one interruption of electricity transmission that the customer has to bear. This cost is related to the network performance. Finally, the quality surplus is calculated from the quality cost. Companies that have low relative quality cost get a large quality surplus and vice versa. (SNEA, 2001; Lavaste, 2001, p. 31.)

After determining the network utility for each company, it is compared with the turnover of the company in question. A cost function is formed with the help of linear regression based on the relation of the network performance and the turnover. The companies that lie far away from the cost curve are taken into closer consideration. (Lavaste, 2001, p. 32.)

4 Advantages and Disadvantages of Practised Regulatory Schemes

The benefit of a regulated third party access compared with the negotiated system, where the market access is based on bilateral agreements between market actors, is that all actors in the market face the same conditions which creates transparency in the market contributing to reduced monopoly power and to non-discriminating prices. Still, all regulatory methods have some advantages and shortcomings. No method is perfect, because it is impossible to design such a method that can take into account all factors that influence the operational environment of the network utilities and still be manageable.

All regulators in the Nordic countries strive for efficiency improvements of the functions in the electricity sector. The regulatory authorities in Finland and Norway evaluate the performance of an electric utility by comparing it with the other firms in the sector by forming a benchmark. The advantage of this approach is that the companies do not benefit by reporting their cost falsely because the result of regulation depends also on the performance of all other firms in the sector. Thus, the problem of asymmetric information can be avoided.

Finland and Sweden base their regulation schemes on ex post price supervision i.e. the reasonableness of pricing is reviewed after the price setting period. This approach is considered to be lighter in realisation and also more flexible than the ex ante schemes, like applied in Denmark and Norway. The disadvantage is, that because the decisions are made individually for the affected utility with the ex post supervision, these systems rely much on the learning effect of the other companies in the sector. This is, however, considered to take place easily because the regulation method is transparent and simple. The ex ante regulation is more inflexible and slow mainly because the regulatory period is often several years long. Ex post supervision nevertheless requires for a *high degree of transparency* in pricing.

The ability of the Danish system to measure efficiency can be criticised because it does not measure the efficiency of the use of capital at all. It also does not take into consideration any differences in the quality of electricity or in the general operational environment. In the Danish as well as in the Norwegian revenue cap system the network utilities can operate like monopolies trying to increase their profit. The method used in Norway can be criticised because the benefits received from the efficiency improvements go mainly to the owners of the companies, not to the customers. The

possible 20 % return on invested capital is rather high for a small risk monopoly actions. The development of the consumer price index and the increase in the amount of distributed electricity might exceed the efficiency requirement, which would fully offset it. The Norwegian system is slow in realising efficiency improvements, because for example the new revenue caps which are set for the period 2002-2006 are based on historical cost information from 1996-1999. Thus, the system is partly based on 6 years old information.

The Finnish electricity market legislation on the other hand leaves the regulator a lot of freedom on how to design the regulatory system. The expression "reasonable pricing" also leaves a lot of room for interpretations. Auer (2002, p. 101) criticises ex post systems because according to him companies are studied only based on complaints from customers, which he considers unfair. Most likely complaints will be issued of companies that have high prices although the prices might be altogether justifiable based on firm-specific structural factors. Thus, according to his view the system does not treat all companies equally. This argument can be questioned since for example in the case of Finland the regulator initiates supervisory processes also on its own partly based on efficiency numbers, not only on complaints. The companies are treated fairly and equally because all companies are aware of the regulatory rules, thus, the system is transparent. In addition, each company received its individual efficiency number two years before the system was applied in the supervisory practice. Hence, the companies had two years time to try to adjust and improve their relative efficiency positions and cost structure. Also in Sweden the firms that lay further from the cost curve are examined more closely from the initiative of the regulatory authority.

One of the main advantages of the Finnish system is that the regulatory effort of the supervisor is low, which brings flexibility and lightness into the system. Also the regulatory organisation remains flat and small. Only those firms are investigated that are suspected of unlawfulness. Due to the large amount of firms operating in the sector it is considered that an ex ante approval method would increase the workload of the supervisor substantially. The individual firms have in any case the best information for forming their own tariffs. It can be expected that they are aware of the criteria on which the reasonable pricing is based and therefore most of the firms independently choose the right price levels because they wish to avoid the negative publicity which would result from an investigation process. Still, the decision holds only for an individual firm and cannot be directly generalised. If the other firms will not learn from this process, it means a large workload for the supervisor.

The system requires a certain level of activity from the supervisor's part and a short processing time for appeals about distribution prices that do not seem to be unreasonable. Setting rules in the markets is difficult and slow in respect of the needs of the market, which can be considered as a lack of the system. Starting an appealing process might prolong the time span during which the firm can continue its unreasonable pricing policy, because the decision of the supervisor is not binding until the appealing process is finished. (EMA, 2001, p. 28.)

The lack of the Swedish fictive network method is that it does not take into account the historical development of firms' structures, which mostly explain the cost and capital structure of the firms today. On the other hand, the fictive network method delivers an objective measure for technical efficiency, according to which the network utilities orient themselves in the real life decision making. Thus, this efficiency improvement practice is a long run process, which delivers a measure for technical efficiency based on the difference between the true network construction and the technically possible structure. A problem is how to measure the cost of interruption for different customers and how to built the quality surplus, that treats all utilities equally irrespective of the structure of customers.

The advantage of this model is that it is unambiguous and it is difficult to manipulate by the companies. Therefore, the problem of asymmetric information can be solved. Also this method is manageable from the regulatory point of view and creates transparency within the system. As a disadvantage of this method is the lack of consideration any factors set by the geography or other environmental factors.

5 Success of Regulation in the Local Distribution Networks

The development of the distribution network prices shows that after the liberalisation of the electricity market in Finland the real distribution network prices have decreased for all type customers. Figure 5.1 shows further that after the first regulatory decision was verified by the supreme administrative court in Finland in February 1999 the prices started to decrease for every customer class. This could implicate that the desired learning effect does take place among the network utilities. Although here it should be noticed that because of the prices also include the prices of the overlaying networks the decreasing trend was enforced by 7 % reduction of the national network pricing in 2000-2001, which can be seen as a slightly accelerating decrease of

prices from January 2000. The sudden increase of prices in May 2001 can be explained solely by the price increase of one of the largest company in the sector.

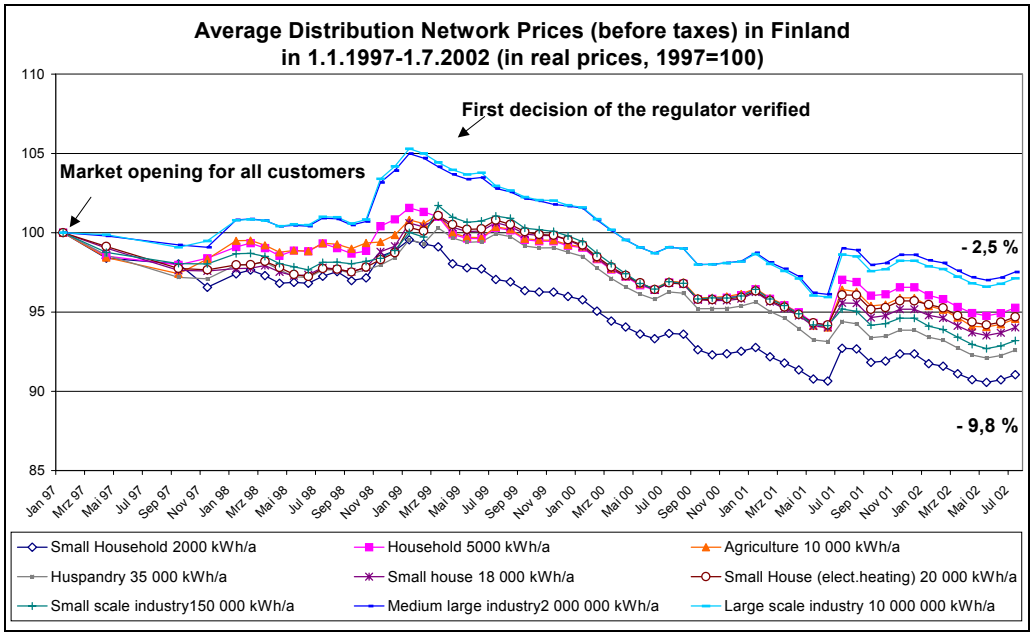

Figure 5.1 Development of the distribution network pricing in Finland in 1.1.1997-1.7.2002. Based on: EMA (2002).

In Sweden the impact of liberalisation is not as clear as in case of Finland (Figure 5.2). There, the impact of regulation is not as easy to interpret. For the households with a yearly consumption of 20 MWh the real price has sunk by - 2,5 % in 1996-2002 and for the large industry by - 4,6 % in 1998-2002. For all other customer groups the prices are higher than in 1998 (and for the other households higher than in 1996). The regulation in Sweden has thus not managed to reduce the distribution prices.

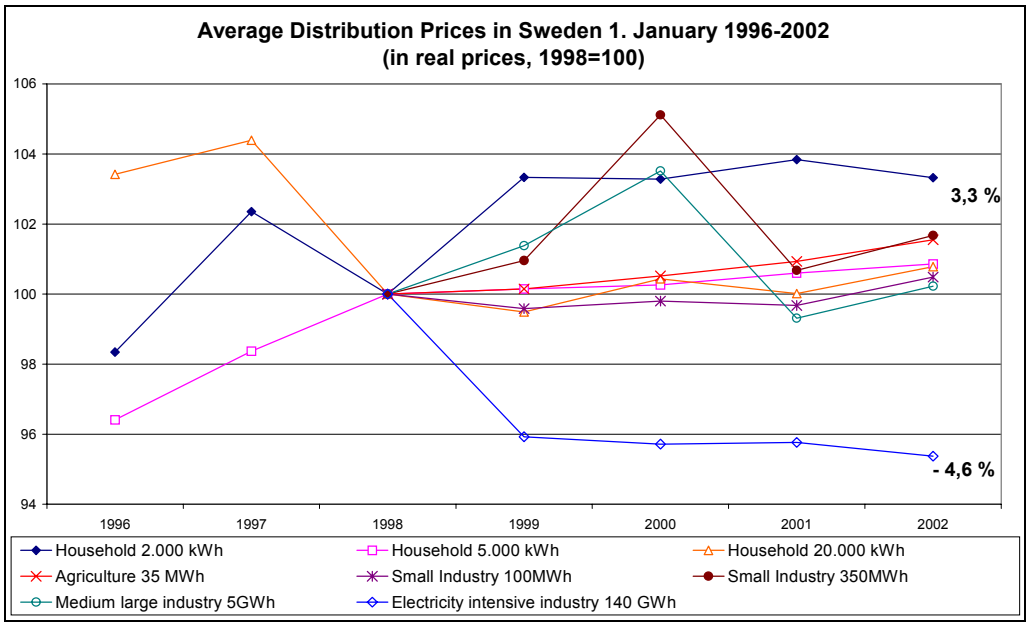

Figure 5.2 Development of the distribution network pricing in Sweden in 1996-2002. Based on: Based on SNEA (2002c).

In Norway the electricity sector has been liberalised for the longest time and this can also be seen as a better result for the three studied customer groups (see Figure 5.3). The real prices have sunk by -19,5 % in 1993-2002 for the medium large industry, at best even almost -25 % in 2001. The influence of the regulatory period can be seen in this figure as a wave-like form. In year 1997 the new regulatory system was introduced and the prices rose. Towards the end of the regulatory period the prices started to sink. And again, at the beginning of a new five year period the prices rose again. This form of price curve could be explained by the fact that, because the firms profit should not exceed the allowed maximum profit *on average* during the whole regulatory period, it is beneficial for the utility to get higher profits at the beginning of the period, even higher than the allowed upper limit, because the money it receives today is more valuable to it than the money it receives tomorrow. It is noteworthy that the prices are at a higher level in 2002 than ever since 1996. For households and large industry even higher than 1995 respectively 1994. This rapid increase could reflect the profit cap of 20 % of the new regulatory scheme which is higher than earlier.

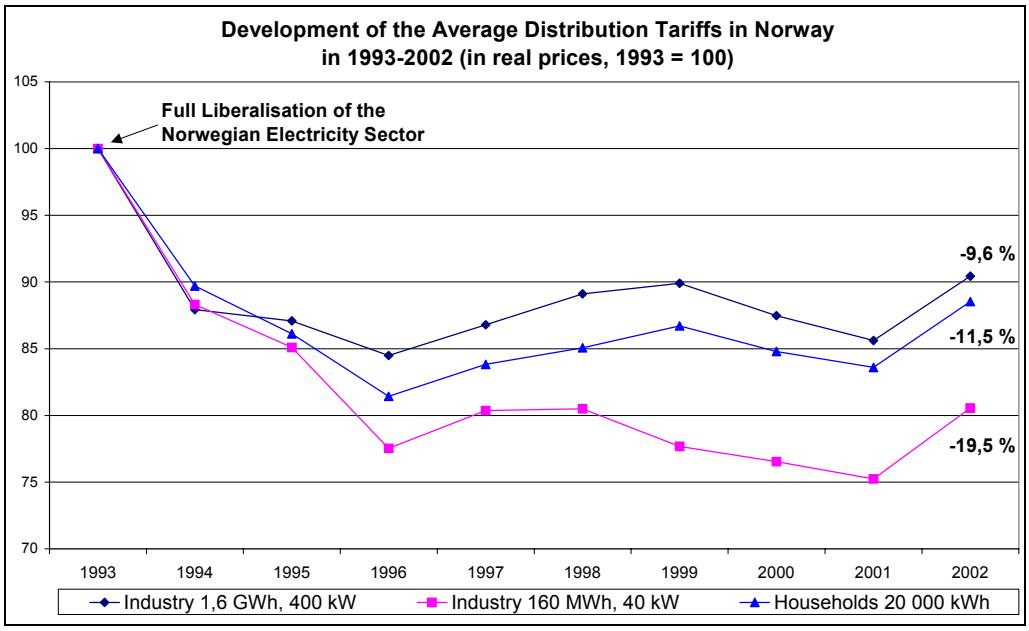

Figure 5.3 Development of the distribution network pricing in Norway in 1993-2002. Based on: NVE (2002).

According to an on-going research about the network pricing in the Nordic countries[4], the efficiency measurement in Finland, Norway and Sweden based on the input-oriented DEA -method with an assumption of variable returns on scale show quite similar relative technical efficiency levels.[5] Efficiency was determined based on selected physical information and cost information of each distribution network utilities. Distributed electricity (MWh) per the length of electric lines (km) was used as an output parameter, the amount of customers as a factor describing the environment (proxy for distribution area), average interruption time per year as a quality factor and the operational cost plus the return on equity was used as input.

First the efficiency for each country was determined from a national sample and second from a total Nordic sample. One characteristic of this method is that when adding one extra company the result for the remaining companies does not get better, often it is even the other way around. The reason for this is that, if the "old" companies are more efficient than the new company their relative efficiency does not change, but if they are less efficient, their relative efficiency will be lower. Thus, the average efficiency numbers for these countries in a total Nordic sample are naturally not as good as the national efficiency results. (In these samples every utility (150) in Norway got a worse efficiency number, in Sweden eight utilities (out of 236) got the same efficiency result and in Finland 18 companies (out of 102) got the same efficiency number.

[4] Detailed information can be found in a Ph.D. thesis of Kaisa Kinnunen "Network Pricing in the Nordic Countries" (not yet published).

Table 5.1 Weighted mean efficiency results for Finland, Norway and Sweden in 2000.

Weighted mean efficiency corrected with 10 % error margin			
	national sample	*total Nordic sample*	*difference between the efficiency numbers in the samples on average*
Finland	0.70	0.66	0.06
Norway	0.86	0.53	0.33
Sweden	0.72	0.66	0.09
All	-	0.63	-

Source: Own calculations based on empirical information published by the respective regulatory authorities for 2000.

The weighted efficiencies are listed in Table 5.1. Distributed energy is used as weights for each company to build an average for the country. A 10 % error margin is added to the efficiency number to eliminate the negative influence of possible measurement errors. The efficiency number is between 0 and 1. Thus, an efficiency number of 0,70 means that the network utilities are on average 70 % efficient.

The two samples cannot be directly compared with each other but it seems that the companies within a country seem to be rather similar in their efficiencies especially in Norway. This could mean that the regulation practices in these countries have succeeded in creating similar conditions for the network utilities inside a country, which makes them reach the similar efficiency levels on average. However, when comparing with the neighbouring countries the situation changes dramatically, which is the case in Norway. In the Nordic sample, the efficiency of Norway is 53 %. Finland's relative efficiency performance in the Nordic sample has reduced the least compared with the national sample. This could reflect that the efficiency level measured with the chosen factors in Finland is quite sustainable also when comparing with other countries. The most efficient companies mainly come from Finland (see Figure 5.4), which would mean that the structure of the best electricity distributing companies is close to optimal measured with these factors, although it should be remembered that the efficiencies are only relative and that there still remains possibilities for improvement.

[5] The required information is not available for Denmark, therefore only these three countries were compared.

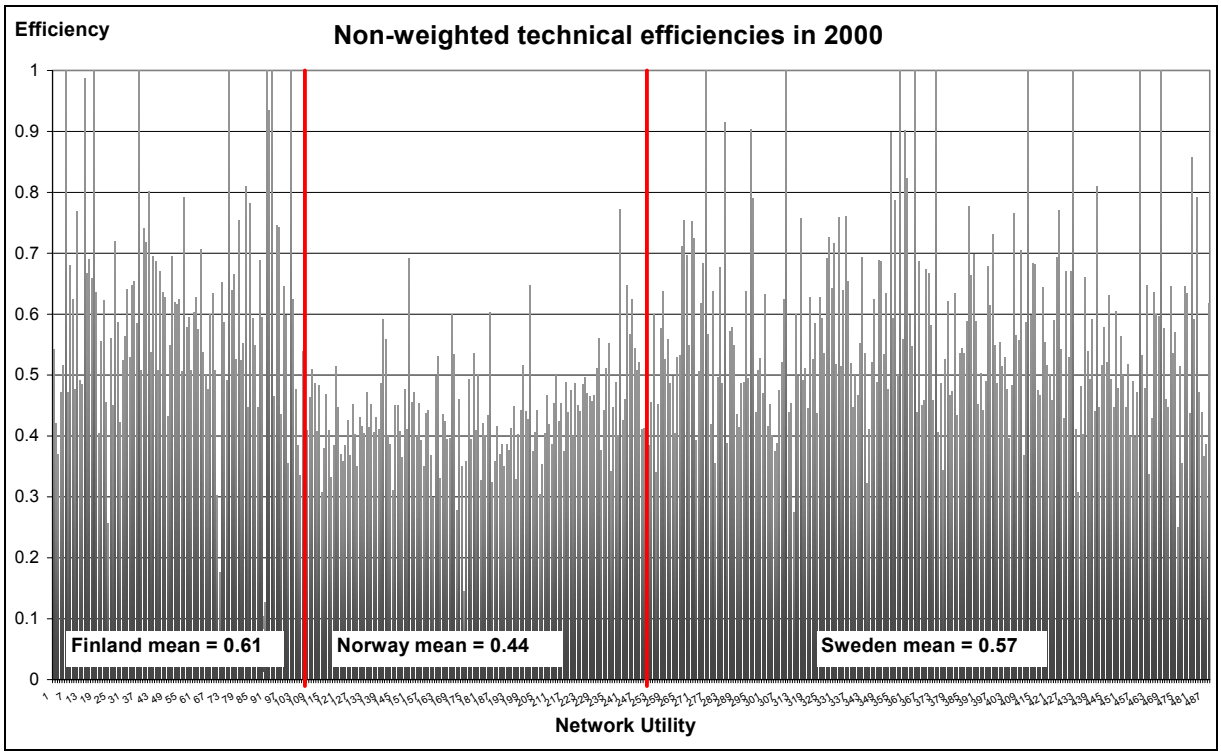

Figure 5.4 Efficiencies of the distribution network utilities in Finland, Norway and Sweden in 2000. Source: own calculations.

The differences in efficiencies inside the total Nordic sample could be considered to reflect only the differences in the geographical and other environmental factors of these countries. On the one hand, geographical conditions in Norway are so much different than in Finland and Sweden, that it can be questioned with reason whether one environmental factor can adequately cover all the differences. There are also structural differences. For example the regional networks distribute almost four times as much electricity in Norway than in the other countries, which could explain the smaller degree of utilisation of the distribution network. Still, on the other hand, the real advantage of the DEA method is that it compares only such utilities that are similar in their outputs, inputs and environmental factors. Thus, to some degree the differences can also reflect the success of the regulation method. This would imply that the ex ante income frames method is not optimal in improving efficiency since the ex post regulated countries show higher efficiencies.

Based on the efficiency number it could be determined how much potential there would be for cost savings in the sector. Added together there could be potential for 1600 million Euro saving in these three countries measured with the total Nordic efficiencies. It would mean that companies could save on average 0,94 cent/kWh. In Finland this potential is 0,55 cent/kWh, in Norway 1,23 cent/kWh and in Sweden 0,91 cent/kWh. When only the national potentials for saving are considered the network utilities in Finland could save 0,47 cent/kWh, the Norwegian utilities 0,57

cent/kWh and the Swedish 0,83 cent/kWh. Naturally, this efficiency improvement can not be expected from the utilities within only one year. When setting three years as a reasonably long adaptation period the cost (and hence also the price) reduction would be for Finland 0,16 - 0,18 cent/kWh, in Norway 0,19 - 0,41 cent/kWh and in Sweden 0,28 - 0,30 cent/kWh annually. For example in Norway the weighted average[6] distribution price in 2002 was 2,46 cent/kWh meaning that the efficient price would be on average between 2,05 and 2,27 cent/kWh.

However, according to the preliminary studies the difference between the cost per kWh and price per kWh was in Finland in 2000 0,5 cent/kWh, in Sweden 0,76 cent/kWh and in Norway only 0,23 cent/kWh. Thus, this lets one to assume that the income frame system in Norway has been more efficient in reducing monopoly rent but less efficient in inducing cost savings than the ex post systems in Finland and Sweden.

6 Conclusions

The efficiency studies of the Nordic countries show that the non-weighted pure (without risk supplement) efficiency numbers are quite low. Thus, the national regulatory regimes have not been successful in inducing efficiency in the electricity distribution sector. The comparison with the neighbouring countries shows that there remains possibilities for further efficiency improvements. Hence, all possibilities for efficiency improvements are not yet taken advantage of. Still, this issue is considered important in all of the Nordic countries and all countries introduce an efficiency requirement in their regulation method.

The performance of the Finnish and Swedish distribution utilities seems to be the most sustainable which speaks for the ex post regulation. However, the geographical and other environmental factors should be taken into account more when comparing between countries. This, however, is difficult, because such information is not publicly available for single network utilities.

In all of the studied countries the network utilities would be able to reduce their cost and thus also be able to lower prices. This would mean a 1600 million € saving in the Nordic electricity bills.

[6] The amount of distributed electricity per type customer was used as weights.

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