REGULATORY ENVIRONMENTS IN RELATION TO THE OBLIGATIONS AND RIGHTS OF ELECTRICITY DISTRIBUTION COMPANIES - EXAMPLES OF NORDIC EXPERIENCES

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INTRODUCTION
This paper describes the electricity distribution business regulation in the Nordic countries – Norway, Sweden and Finland and the measures taken to comply with the new electricity market directive (2003/54/EC). The different characteristics of the regulation are outlined and compared – especially focusing on the efficiency requirements, power quality regulation and the role of benchmarking. The differences in capital base assessment and allowed profit are also discussed. The purpose is to determine how the measures taken in each country reflect to the obligations and rights assigned in the directive to the networks companies.

REGULATION OF NETWORK COMPANIES
European Commission’s directive 96/92/EC given in 1996 set the common guidelines for the internal market in electricity. Amending directive 2003/54/EC was to contribute to the development. Among other things the directive concentrates on protecting the interests of the customers. Electricity distribution is a natural monopoly and therefore it must be regulated so that companies do not take advantage of their monopoly position. This is done by assigning certain obligations to the electricity distribution companies. The most important aspects are reasonable price levels and quality of supply; customers have a right to be supplied with electricity of a specified quality at reasonable, clearly comparable and transparent prices [1]. Regulation of the electricity distribution business has a key-role in reaching these goals because it defines the operational framework of the distribution companies.

Electricity distribution is a business characterised as capital-intensive; long asset lifetimes and anticipatory long-term planning of networks have to be taken into account while considering proper regulation. Regulation should provide distribution companies with incentives to keep distribution networks in appropriate technical shape in the long term. According to the directive 2003/54/EC the distribution system operator shall maintain a secure, reliable and efficient electricity distribution system in its area with due regard for the environment [1]. Quality of supply is generally concerned with interruptions and voltage quality. Regulators may rely on standards and/or their own judgments in defining the specifications, and they also take into account the differences of the requirements of different customer groups.

New regulatory requirements of the directive include ex-ante approval of at least the methodologies used for network access charges in order to avoid uncertainty and costly and time consuming disputes [1]. National regulatory authorities must ensure that transmission and distribution tariffs are non-discriminatory and cost-reflective. The distribution tariffs should be sufficient to allow the necessary investments in the networks to be carried out in a manner allowing the viability of the networks [1]. Also service issues are dealt with, e.g. the decisions concerning complaints against distribution system operators, have to be made within at least four months. The directive also emphasizes the long-term marginal avoided network costs from distributed generation and demand-side management measures as an import price signal and hence as an important parameter for cost/benefit analysis. The regulators may, for instance, address these issues by applying specific targeted incentive schemes.

Regulation principles
The directive does not give any specific details on how the regulation of electricity distribution business should be enforced. Rather, the directive leaves room for different interpretations, which means that there are large variations in regulatory models in different countries. Furthermore new requirements of the directive have forced some countries such as Sweden and Finland to modify their regulation methods.

Regulation of electricity distribution business is a challenging task of balancing the expectations of the customers, the networks companies and the investors. The structure of general regulation principles can be seen in Fig. 1. The figure contains general characteristics of operation of network companies. Regulators determine the allowed revenue or regulate individual cost components separately. These components are operational costs, depreciations, costs of losses, rate of return and a possible penalty or reward depending on power quality. Rate of return is set by the regulator, historic data may be used to determine operational costs as well as depreciations. Efficiency requirements will result in declining revenues where as quality adjustments may
either increase or decrease allowed revenues. The desired trend is to reduce the revenue of the network companies by efficient operation, despite of regulation model used.

![Image of efficiency requirements](image)

**REGULATION IN NORDIC COUNTRIES**

The measures taken by the Nordic countries – Finland, Norway and Sweden - in order to comply with the directive in electricity distribution business regulation vary greatly. Norway has to comply with the directive through the EEA agreement (European Economic Area). All the Nordic countries have electricity distribution sectors resembling one another; the number of distribution companies is quite high, there are companies of different sizes and there is a similar tradition of public service utilities [2]. The countries also share a common pool for the wholesale of electricity. The reasons for variations in the regulation are partly historical; the initial reasons for starting the development process of regulation models have differed. The driving forces may have been due to problems in present regulatory models, lack of efficiency incentives or legislative changes, such as revisions of energy laws and the new EU directive.

**Finland**

The opening of the electricity market in Finland took place in 1995. The goals introduced for regulation were improving the efficiency of the monopoly business and setting the distribution prices at reasonable level. Hence rate-of-return regulation was introduced. The companies could expect riskless profits in addition to covering their costs. The DEA (Data Envelopment Analysis) efficiency benchmarking method was introduced in 2000, but it could not be implemented in the regulatory process as hoped [3]. Finally it was used only for rewarding companies considered efficient. The DEA scores are calculated today only for informational purposes. The initial model had to be modified from the beginning of 2005 on account of the new directive. As in the former rate-of-return model the companies were investigated based on appeals in retrospect, now all the companies are given framework for economical operation in beforehand for a certain period of time, although decisions concerning possible over-return are made afterwards [4]. In the new regulation model the regulator sets limits to different cost items; operational costs, depreciations and return. A specified efficiency requirement is used to regulate the operational costs. The requirement is the same for all of the companies and it is based on the productivity growth of the sector. There has not been any detailed regulation on the quality of electricity supply, but quality issues are not entirely ignored. The fulfillment of obligation to develop networks is monitored and supply interruptions are used as a parameter efficiency analysis and hence used for rewarding efficient companies. In the present regulation period certain quality parameters are monitored by the regulator, but there are no specific regulations.

**Norway**

Norway has been a leading country in electricity distribution regulation and has many years of experience in developing the regulation model in co-operation with the companies. Market opening took place in 1991 and rate-of-return regulation was introduced. Originally the aims were to make the business more effective. Now the regulation model has incentives for efficiency as well as quality improvements that take into account individual differences [5]. The allowed revenue is reduced annually based on a general and a company-specific efficiency requirement. The general efficiency requirement is based on forecasted growth of productivity and the individual efficiency targets are based on DEA benchmarking. The results of efficiency benchmarking are applied with some caution taking into account that restructuring of an inefficient grid takes a long time. The companies are not expected to reach fully efficient state during one regulation period. 50% of the individual inefficiency for each utility is expected to be caught up during the five year regulatory period. The allowed revenue is also modified based on company performance against expected values of interruption costs [5]. All the different elements in the model make it challenging for the companies; business risks can be higher as well as profits.

**Sweden**

In Sweden there has not been a specific regulatory model since the market opening in 1996, until now. Reforms in energy law in 2002 changed the regulation to performance based, so it was consistent with the directive. The Network Performance Assessment Model (NPAM) was enforced in the beginning of 2003. The model builds up a fictitious network deemed efficient using today’s technology for every company. Data from the company in question is used to construct the fictitious network [6]. The cost of running this network generates revenue, which is then compared to the actual revenue. Hence billing ratio is formed. If a company fails to fit in the target revenue, it will be investigated in detail. The regulator aims to encourage self-regulation on the companies, i.e. companies will act according to conduct codes without regulatory intervention based on the result of the billing ratio [6]. The use of the model has raised some questions on the directing effects of the regulation as well on functioning of the model itself. The fictive network concept...
can be demanding to develop so that the needs of the actual network are taken into account [7].

**Summary of regulation principles**

Table 1 shows how the three countries with similar backgrounds have chosen different ways in fulfilling the obligations to regulate electricity distribution monopolies. Finland and Sweden have used ex-post regulation, while Norway has applied an ex-ante regulation model. All the countries have efficiency requirements in place, as well as some sort of quality regulation.

<table>
<thead>
<tr>
<th></th>
<th>Regulation method</th>
<th>Efficiency requirement</th>
<th>Quality incentives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland</td>
<td>Ex-post</td>
<td>General</td>
<td>Quality parameters are monitored</td>
</tr>
<tr>
<td></td>
<td>Rate-of-return</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td>Ex-ante</td>
<td>General and individual based on DEA</td>
<td>Interruption costs affect allowed revenue and DEA scores</td>
</tr>
<tr>
<td></td>
<td>Revenue cap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>Ex-post</td>
<td>Fictitious network determines efficient revenue</td>
<td>Actual outages affect the allowed revenue</td>
</tr>
<tr>
<td></td>
<td>NPAM</td>
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</table>

**TABLE 1 – Regulation of electricity distribution business in the Nordic countries.**

**THE CHARACTERISTICS OF REGULATION**

Incentives for the development of networks have taken many forms in economic regulation. Incentives can have significant effects on the network companies’ operation, and experience shows that the utilities adjust their operations and decision-making according to the regulatory framework. Therefore the long-term effects of incentives must be evident; there is a chance that companies may face a situation where they cannot be guaranteed a viable operating environment contrary to the electricity market directive’s spirit.

**Regulatory period**

The changes in the electricity market directive aim to provide stable, predictable operation environments. Regulation periods help provide that stability. Finland has adopted a four-year regulation period after the initial three-year period of 2005-2007. Previously the period was one year. Norway has a regulation period of five years and the Swedish model considers reasonable pricing on an annual basis. One year regulation period can generate uncertainty concerning long-term economical decisions faced by the network companies, although the parameters of the Swedish regulation are fixed for a base year and then indexed to following years.

**Return**

The directive does not give any specifications about the level of allowed profit to be received in regulation. The issue of allowed return is notable due to the profit expectations from the companies in order to them to make necessary investment to the network. In addition this can have effect on the interest towards the sector stemming from investors. Low profits do not attract new investors. The average profit for invested capital was 10% in 2003 in Finland [8]. The allowed profit is calculated using WACC method (Weighted Average Cost of Capital), the interest for equity was 4.78% and 3.57% for debt assets in 2003. In Norway the average profit determined by the regulator is 7.69% [5]. However the actual profit earned by the companies each year has limits set by the regulator; the minimum is 2% and maximum 20%. Network company’s ability to make good business decisions is a key factor in the profit earning. The Swedish method for determining capital costs is different. The regulator first forms capital base from the re-purchase value of the fictive network and the capital costs are calculated using annuity. In the calculations a 4.8% interest rate and 40 year period of depreciation are used [6].

Following from this it is evident that profit possibilities are different in different countries. The directive does not however require equal conditions in each member country but rather that there are enough funds for necessary investments for networks in question. Differences in profit expectations can be partly explained by different capital base selections.

**Regulatory asset base**

In the Finnish model the capital base is determined annually as the present value of the network. The present value method applied uses standard prices for network components. The present value changes each year as investment decisions are made during the regulation period. Straight-line depreciation on network present value, where companies can to a certain extend affect the periods of depreciation, is used. In Norway the book value of the companies’ network is used as capital base, with an addition of 1% for working capital. Depreciations are also book values. This method can be problematic as deprecations may have reduced the capital base so that the book value does not reflect the proper value of the assets. In the Swedish model the use of capital base obtained from the fictitious network is also problematic due to the fact that the historical events, which have led to present situation, are not taken into account. Electricity distribution networks have been built over several decades with the best knowledge and technique available at the time. The fictive company has the best possible network available today. The use of fictitious network can lead to a situation where the costs could be too low to cover the fixed and common costs of the actual network company. Experiences of the NPAM will tell if this is the case in Sweden.

**Efficiency**

The task of monitoring network companies so that they maintain a secure, reliable and efficient electricity distribution system is a challenging one.

Finland has introduced efficiency requirements for operational expenses only recently. The target for efficiency is the average operational expenses of the years 2000-2003. The efficiency requirement is 1.3% annually, the figure is obtained through productivity change in the sector. Since the
regulation of network companies has focused on the rate of return, there have been no specific incentives to reduce costs. However the pressure stemming from the publication of the DEA efficiency benchmarking results and the indications that these results were to be used in regulation of operational expenses may have acted as an incentive.

Revenue cap regulation on the other hand has incentives to reduce costs in order to companies get more profits for themselves. In addition the regulator usually sets an efficiency requirement for the revenue. This is the case in Norway and Sweden. The Norwegian efficiency benchmarking has been in place since 1997. Norway has used the DEA method in determining company-specific efficiency requirements for the allowed revenue. In the present regulation period the general efficiency requirement is 1.5 % and the individual requirement in the range 0-5.2 %, depending on the company-specific modified DEA-score.

The level of efficiency required by the Swedish regulator depends entirely on the performance against the fictive network company. A pilot study conducted in year 2001 resulted in an average ratio of 1.2 between the company’s revenue and the fictive company’s revenue, while another study from 2003 showed a ratio of 1.105 [7]. The changes are due to modifications in the model in order to get a regulation model that is accepted by the regulator and the companies since there has not been any specific regulation method in place until the beginning of 2003. The development of NPAM in Sweden has however taken several years, so the threat of regulatory intervention has acted as guidance. But on the other hand the companies have had intensives to cut back costs in order to obtain higher profits.

Expenses have traditionally been the target of rationalising operation. Determining reasonable level of operational costs is a challenging task. The Swedish regulatory model determines the reasonable operation and maintenance expenses as a percentage of the repurchase value of the fictive network. This figure is 2.2 % for 20 Swedish network companies. The actual average ratio of operation and maintenance expenses and repurchase value in year 2003 for these companies was 3.8 %. The same actual figures for Finland and Norway are 4.5 % and 3.2 %, respectively. The level of efficiency such as required in Sweden might be hard to fulfill.

**Power quality regulation**

When the subject of rationalising operations is concerned, quality issues are often raised. Excess efficiency improvements can result in deterioration of security of supply. As distribution system operators shall maintain a secure, reliable and efficient electricity distribution system, it is the regulators’ responsibility to monitor the implementation. The regulators may rely on standards and/or their own judgments in defining the specifications, and they also take into account the differences of the requirements of different customer groups.

The Finnish approach is quite light handed; the fulfillment of obligation to develop networks stated in the electricity market act is monitored. This is done by monitoring quality figures that eventually will act as reference values in the forthcoming regulation periods. Therefore the companies have incentive to at least maintain present quality level.

Norway’s approach is more detailed. Quality adjusted revenue caps by means of energy not supplied provides an expected level for interruption costs. If a company beats the target level, its’ allowed revenue is increased and vice versa. In addition Norway has introduced a new quality of supply regulation setting specific limits for certain power quality characteristics [9]. Also service quality issues are dealt with and coordinated with the Directive 2003/54/EC.

The Swedish model has strong incentives for quality improvements; network companies are provided a reliability target that is based on reliability simulations on the fictive network. Companies, whose actual interruption costs are smaller that the expected costs, receive allowed revenue in full. If it fails, the revenue is decreased and the company is more likely to be considered to be overcharging.

Quality incentive schemes are usually scheduled for a short period of time, although companies have made investment decisions in a long-term perspective. This fact has to be taken into account as quality incentives continue to develop more diverse. Specified quality of electricity distribution that the customers have a right to enjoy would require clearly defined levels of quality expectations. The ongoing standardisation work in IEC and CENELEC (TC8 and TC8X) might support this need and EN 50160 is already an important standard defining voltage characteristics and what levels that might be expected throughout Europe.
Summary of Nordic experiences

Regulation principles and models in Finland, Norway and Sweden differ, as shown in tables 2 and 3. For instance the allowed profits and regulatory capital bases are different in each country.

TABLE 2 – Economical differences in the regulation models in the Nordic countries in year 2003. Losses are not included in the calculations.

<table>
<thead>
<tr>
<th>Country</th>
<th>Operational and maintenance expenses / repurchase value of capital</th>
<th>Allowed profit on capital base</th>
<th>Capital base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland</td>
<td>~4.5 % WACC: 4.78 % on equity, 3.57 % on debt – 10 % on average on invested capital (book value)</td>
<td>Present value of the network</td>
<td>Present value of network</td>
</tr>
<tr>
<td>Norway</td>
<td>~3.2 % 7.69 % on average – the allowed profit is up to 20 %</td>
<td>Network book value + 1 % for working capital</td>
<td>Network book value + 1 % for working capital</td>
</tr>
<tr>
<td>Sweden</td>
<td>~2.2 % (fictive network) – 3.8 % (actual network) 4.8 %</td>
<td>Based on fictive network’s replacement value</td>
<td>Based on fictive network’s replacement value</td>
</tr>
</tbody>
</table>

A lot of effort has been put in developing efficiency benchmarking methods in the Nordic countries. The goal has been e.g. to improve the robustness of the results as well as the quality of the input data. The work on these issues still continues.

TABLE 3 – Efficiency requirements in the Nordic countries.

<table>
<thead>
<tr>
<th>Country</th>
<th>Benchmarking method</th>
<th>Efficiency requirement</th>
<th>Target for efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland</td>
<td>DEA</td>
<td>1.3%</td>
<td>Operational expenses</td>
</tr>
<tr>
<td>Norway</td>
<td>DEA</td>
<td>1.5% general 0…5.2 % individual</td>
<td>Revenue</td>
</tr>
<tr>
<td>Sweden</td>
<td>NPAM</td>
<td>Depends on the fictive network company</td>
<td>Revenue</td>
</tr>
</tbody>
</table>

CONCLUSION

Although the Nordic countries – Finland, Norway and Sweden – have electricity sectors resembling one another, the methods used to regulate electricity distribution business vary. Because of different economic approaches to regulation, it is nearly impossible to compare the business possibilities for electricity distribution companies. This raises questions whether similar regulatory approaches could be adopted in all of the Nordic countries.

Regulation of electricity distribution business has a key-role in reaching different goals set by the regulator, because it defines the operational framework of the companies. The Finnish model used in the regulation of electricity distribution business has undergone changes recently in order to comply with the new requirements of the electricity market directive. The model provides riskless profits for the companies. The Norwegian model on the other hand is quite challenging for the network companies. The model has greater risks but also the profit opportunities can be higher. From the Swedish model there are little experiences yet, but it appears to be quite strict in determining the efficiency. The revenues determined based on fictive network may not be sufficient for network companies to operate, maintain and develop their existing networks. All the models aim to bring reasonable prices and good quality of service to the customers while ensuring the viability of the network companies. The long-term effects of these goals remain to be seen.

REFERENCES