PERFORMANCE BASED RATEMAKING
IN ELECTRIC DISTRIBUTION SERVICES

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ABSTRACT

PERFORMANCE BASED RATEMAKING
IN ELECTRIC DISTRIBUTION SERVICES

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Regulation is one of the main elements in electric distribution services. The objective of the regulation is to maintain the balance between the rates and service quality of electric distribution on behalf of both utilities and customers. In rapidly changing world the regulation regimes are also changing .In this thesis, an increasingly implemented regulation model in electric distribution, performance based ratemaking is studied. Its advantages and disadvantages, implementing methods and its quality effects are analyzed.

Keywords: Performance Based Ratemaking, Regulation in Electric Distribution Service

ÖZ

ELEKTRİK DAĞITIM SERVİSLERİNDE PERFORMANS TABANLI DERECELENDİRME

Uğuz, Mustafa

Yüksek Lisans, Elektrik ve Elektronik Mühendisliği Bölümü

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Elektrik dağıtım sisteminde regülasyon çok önemli bir ögedir. Regülasyonun amacı ücretler ile servis kalitesi arasındaki dengeyi hem elektrik dağıtım kuruluşları hem de tüketiciler adına sağlamaktır. Hızla değişen dünyada regülasyon yönetimleri de hızla değişmektedir.Bu tezde elektrik dağıtım sistemlerinde giderek kullanımı artan bir regülasyon yöntemi olan, performans tabanlı derecelendirme incelenmiştir. Bu yöntemin faydaları, dezavantajları, uygulama biçimleri ve elektrik dağıtım kalitesine olan etkileri araştırılmıştır.

Anahtar Kelimeler: Performans Esaslı Değerlendirme , Elektrik Dağıtım Sistemlerinde Düzenleme .

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INTRODUCTION

1.1. Electric Distribution

Electric Utility is a legal entity that operates facilities for the generation, transmission, distribution, and sales of electric energy for the industrial, commercial and residential consumption. Electric utilities are examined in three main groups such as, generation utilities, transmission utilities and distribution utilities.

Electricity generation is the first process in electric industry. The other two processes are electric power transmission and electric distribution. Electric generation utilities are mainly deal with producing electric power. Electric power is generated from nuclear plants, hydroelectric plants and thermoelectric plants. Electric power can also be supplied from natural sources like solar energy, wind and geothermal sources.

Electric transmission utilities are transferring electrical power from place to place. Power transmission is between the power plant and a substation near a populated area. Electric transmission is distinct from electric distribution, which is concerned with the delivery from the substation to the customers.

Electric distribution includes local wires, transformers, substations and other equipment used to deliver electricity to end users from the high voltage transmission lines. Electric distribution utilities deal with this issue. The main regulated part of the electric industry is electric distribution service and this study will mainly focus on regulation techniques of electric distribution service.

1.2. Electric Distribution Service

Electric distribution service is the final stage in the delivery of electricity. It is generally considered to include medium voltage (less than 50 kV) power lines, low voltage electrical substations, pole-mounted transformers, low voltage (less than 1000 V) distribution wiring, electricity meters, the network of wires and equipment that carries electric energy from the transmission system to the customers. The costs to support, operate and maintain this local delivery system are included in rates and are usually priced per kilowatt hour for customers.

Electric distribution systems links electric generation and transmission systems with the end users through a network of power lines and associated components. In Turkey distribution part of the system works 34,5-31.0 kV as the medium voltage and operates at 380/220 Volts as the low voltage .The system operating frequency is 50 Hz. A differentiation is made between primary distribution (34,5 kV) and secondary distribution (220/380V) systems. Industrial and commercial customers with large power consumption get services directly from the primary distribution system.

Transformers are important connections in the electric distribution system. Utility transformers are high voltage distribution transformers generally used by utilities to step down the voltage of electricity supplied to their customers. Distribution transformers are one of the most important components in the electric distribution system. They convert electricity from high voltage levels in utility transmission systems to voltage levels that can safely be used in domestic consumption. Distribution transformers are either connected on overhead poles or on concrete houses called "kiosk". Most commercial and industrial buildings require several low voltage transformers to reduce the voltage level of electricity received from the utility to the levels suitable for power lights, computers, and many electrical components.

1.3. Regulation In Electric Distribution Services

Regulation in electric distribution service is for creating rules and methods with applying them to provide adequate, continuous, reliable, sufficient quality electricity at reasonable prices to the customers. In order to realize this objective ,an independent and authorized regulatory authority must be in established.

Regulatory authorities implement various kinds of regulation models for different objectives. They are assigned duties of developing regulatory authority models that all meets the needs of different groups; such as end users, distribution utilities, investors, shareholders and public.

The regulatory authority model should protect the customers from excessive prices of electricity services for being monopoly in the region. Regulatory authorities are expected to allow distribution utilities sufficient returns to cover the costs of capital and to confirm in advance the methods used in determining regulatory authority asset base, reasonable operational costs and reasonable capital expenditure [26]. The customers dependent on services should not be overpriced and the quality of services should be satisfactory. Performing with respect to these issues necessitates reasonable prices and quality in distribution service , which are determined by the regulatory authority previously.

Regulatory model should give incentives for maximum capacity expansion and capacity utilizations, and it should act all distribution utilities in the same indiscriminately manner. Monopoly public utilities have an obligation to deliver products and services at an acceptable level of quality and reliability for the lowest possible cost [17]. The proper incentives are so important in order to keep the electric distribution in consistent situation. In order to avoid conflicting incentives, the regulation rules should be adopted with the general planning and operating principles of distribution systems. The regulatory model should protect investors by providing reasonable returns on investments. On the other hand , regulation should not reduce the competitiveness of electric distribution utility. In order to achieve this target, restrictions has to be imposed on the costs in distribution business. The costs of executing regulatory actions should be in accordance with the presumed cost savings. The regulatory authority should not have to deal with minor company specific details and the cost saving targets specified by the regulatory authority should be easy for the distribution utilities to yield.

In flourishing regulatory models, the main aim is on cost reductions. As regulatory authorities have obtained more information on the activities of the distribution utilities, they can introduce incentives dealing with electric quality subjects. This causes very sophisticated regulatory models, which may not be easy for to understand and accept. Rather than this, simplicity might contribute to the acceptability of the regulation models.

Some certain traditional regulation techniques are considered as an efficient tool to handle the problems being faced and these are widely in implementation in many countries. But the regulation techniques differ from one country to another.

In Turkey electric distribution is regulated by Electric Market Regulation Commission. It regulates 21 electricity distribution companies.5 of them are in operation since 13.03.2003. Licenses of 16 new electricity distribution companies were approved on 01.09.2006. These are;

- Başkent Electricity Distribution Company (13.3.2003-10 years)

(Ankara,Kırıkkale,Çankırı,Karabük,Kastamonu,Zonguldak,Bartın)

- Boğaziçi Electricity Distribution Company (13.3.2003-10 years)

(İstanbul European Side)

- Meram Electricity Distribution Company (13.3.2003-10 years)

(Konya,Aksaray,Karaman,Niğde,Nevşehir,Kırşehir)

- Sakarya Electricity Distribution Company (13.3.2003-10 years)

(Kocaeli,Düzce,Sakarya,Bolu)

- Trakya Electricity Distribution Company (13.3.2003-10 years)

(Tekirdağ,Kırklareli,Edirne)

- Kayseri Electricity Distribution Company (1.9.2006-30 years)

(Kayseri)

- Akdeniz Electricity Distribution Company (1.9.2006-30 years)

(Burdur,Antalya,Isparta)

- Aras Electricity Distribution Company (1.9.2006-30 years)

(Erzincan,Bayburt,Erzurum,Kars,Ardahan,Iğdır,Ağrı)

- Çamlıbel Electricity Distribution Company (1.9.2006-30 years)

(Sivas,Yozgat,Tokat)

- Çoruh Electricity Distribution Company (1.9.2006-30 years)

(Giresun,Trabzon,Gümüşhane,Rize,Artvin)

- Dicle Electricity Distribution Company (1.9.2006-30 years)

(Diyarbakır,Batman,Siirt,Şanlıurfa,Mardin,Şırnak)

- Fırat Electricity Distribution Company (1.9.2006-30 years)

(Malatya,Elazığ,Tunceli,Bingöl)

- Gediz Electricity Distribution Company (1.9.2006-30 years)

(İzmir, Manisa)

- Göksu Electricity Distribution Company (1.9.2006-30 years)

(Kahramanmaraş,Adıyaman)

- İstanbul Electricity Distribution Company (1.9.2006-30 years)

(İstanbul Anatolian Side)

- Menderes Electricity Distribution Company (1.9.2006-30 years)

(Aydın,Muğla,Denizli)

- Osmangazi Electricity Distribution Company (1.9.2006-30 years)

(Uşak,Afyon,Kütahya,Bilecik,Eskişehir)

- Toroslar Electricity Distribution Company (1.9.2006-30 years)

(Mersin,Adana,Osmaniye,Gaziantep,Hatay)

- Uludağ Electricity Distribution Company (1.9.2006-30 years)

(Çanakkale,Balıkesir,Bursa,Yalova)

- Vangölü Electricity Distribution Company (1.9.2006-30 years)

(Muş,Bitlis,Van,Hakkari)

- Yeşilırmak Electricity Distribution Company (1.9.2006-30 years)

(Sinop,Samsun,Ordu,Amasya,Çorum)

1.3.1. Regulation Targets in Electric Distribution

The main objective of the regulation is to maintain the balance between the rates and service quality of electric distribution systems on behalf of both utilities and customers. ”Without regulation, it is likely that the monopoly results are higher prices, lower output levels, and excess profits that exist over time. The goal of the regulation is to force utility to price and offer the amount and quality of services that a competitive entity would offer. Thus the regulatory authority attempts to simulate competitive conditions” [1].

By regulations, electric distribution utilities are robustly being pushed to competitive conditions. These competitive conditions are usually satisfied under the control of the regulatory authority, which try to provide;

- Reasonable prices to encourage effective use of the electric distribution services.
- To fulfill all public and environmental expectations.
- To prevent excess profits at customers' rates.
- The electric distribution utilities being economically strong.
- Sufficient level of service quality.
- Preventing discrimination.

While not making any discrimination among the electric utilities.

A regulatory authority assigned with these responsibilities and must be equipped with power to realize these objectives. The difficulty for electric distribution utilities is to align their strategies and duties with the regulation principles while the profitability of the service is still maintained. When the electric distribution utilities' decisions are focused on common sense rather than a detailed understanding of the utilities' regulation principle, profitability will be decreased. This is the main fear for industries that recover their investments over longer periods.

Dr. Charles Philips from Washington and Lee University offers five basic objectives of regulation [2].

- "Commissions have sought to prevent excessive profits and unreasonable price discrimination among customers and regions. This objective is essentially a negative or restrictive one.

- Commissions have tried to assure adequate earnings so that the public sector could continue to develop and expand in accordance with consumer demands. Profits, however, are not guaranteed, and incentives to efficiency have received little attention.

- Commissions have sought to provide service to the maximum number of customers. In some instances, competition has been limited to permit internal subsidies. (Low density feeders may be subsidized by earnings on high density feeders). More recently, conservation and new entry have resulted in a growing emphasis upon cost based rates, thereby forcing commissions to reevaluate the use of internal subsidies to achieve this objective.

- Commissions have often promoted the development of an industry. Rate structures have been designed to promote growth (declining block rates) or subsidies have been given to achieve this objective (rural electric cooperatives). Federal public power projects were undertaken to promote the industrial development of specific regions.

- Commissions, in some instances, have been or are rapidly becoming concerned with insuring, maximum public safety and management efficiency. ”

Natural monopolies have traditionally been subject to regulation because they pose risks to the society by getting excessive profits and costs at the expense customers dependent on their services [3]. Creating an efficient business environment in electricity distribution by regulation is a challenging task because of the nature of the industry. 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 utilization, which requires fluctuating prices [4].

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 [5]. In addition, regulation should be acceptable to regulated companies and maximizes the overall social welfare by promoting efficient operation [6].

In electricity distribution business common forms of regulation are;

- rate of return regulation
- price regulation.

Rate of return regulation provides the regulated companies with sufficient incentives for capacity expansion. The rate of return regulation even creates incentives for overcapitalization, which actually seems to have been the case in the Scandinavian distribution industry prior to deregulation [3]. 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 support capacity expansion.

On the basis of the electric distribution utility, the regulatory authority chooses either unit prices or total revenue for the electric distribution company. If the electric distribution utility's costs increase with volume, the regulatory authority will implement a price control and set a maximum price per unit. If the utility's costs are not related with volume, then the regulatory authority will implement a revenue control and will set maximum revenue for the electric distribution utility. Both strategies are not exclusive; a regulated electric distribution utility can have a control that is some price related and some revenue related.

1.3.2. Difficulties of Regulation

The regulatory authority is responsible for controlling electric distribution utilities by compromising the interests of customers and investors. These utilities are in huge size and have tremendous capability and functionality. While regulating these electric utilities, regulatory authority confronts the difficulty of finding a true regulatory mechanism, which suits the diversity of capabilities, functionalities, locations and market structure of these utilities. If the regulatory authority cannot implement the correct regulation mechanism, the fair balance between the customers and investors cannot be maintained and this deteriorates the regulation system.

Most of the electricity utilities have both regulated and unregulated functions. These functions must be correctly determined and defined by the regulatory authority. Defining and determining these unregulated functions and controlling them in a common base without any discrimination and without effecting the operation of utilities is a great challenge for the regulatory authority.

The competition and choice in industry changes the characteristics of electric distribution system. Some customers wish to bypass distribution grid. New technologies like transmitting telephone signals or Internet signals over electric distribution wires, results in competitive offerings. In these situations regulatory authority has to find a suitable modification in order to integrate the new technology into the regulation system.

Due to the above reasons, an ideal and well designed regulatory system must satisfy the new responsibilities of the utility and technologies adopted, it must be flexible enough to meet the rapidly changing situations of the market, it must effectively deal with the utilities that it regulates, always be familiar with the social and customer interests. Performing all of these functions at the same time is a great challenge and difficulty or even an obstacle for the regulatory authority.

1.3.3. Types of Regulation in Electric Distribution Systems

Most common regulation types having been implemented in electric distribution system are;

- Cost of service / Rate of return regulation.
- Incentive based regulation.
- Technology based regulation.
- Sliding scale plans .
- Price cap regulation.
- Revenue cap regulation.
- Yardstick competition.

1.3.4. Traditional Regulation Principle In Electric Distribution

In today's electric distribution system most common regulation mechanism is the cost of service/rate of return regulation. Traditional electric distribution utility regulation provides for determining an electric distribution utility's cost of service and then allowing the utility to collect all of its reasonable costs in the rates customers pay.

Regulatory authorities implement cost of service/rate of return regulation to set prices for electric distribution utilities. Under cost of service/rate of return regulation, prices are set to assure a specific return on investment after taking back all the incurred operating costs. Therefore, the electric distribution utilities have relatively little incentives to reduce the costs, since the cost reduction causes decreases in prices and therefore, in profits. There is also administrative inefficiency, because the costs of monitoring the sophisticated activities of the utility in case of cost of service / rate of return regulation are relatively high [8]. The problem is actually a broad area of economics field , covering any problem resulting from an asymmetry of information between a regulatory authority who wants something done and an utility who actually has to do the work [18].

Cost of service/rate of return regulation is often used for electric distribution utilities to prevent exploiting monopoly power. An electric utility must be forbidden to earn above a certain rate of return determined by the regulatory authority. In practice, this often encourages the utility to be inefficient, slow to innovate and quick to spend money to keep down its profits and thus the rate of return.

Cost of service/rate of return regulation mechanisms have been long periods of time proved that it is reasonably effective at achieving important public policy objectives. New structures and demands in energy area and electric distribution service led to be the reason of the conclusion that cost of service/rate of return regulation is too slow, too rigid, and too sophisticated to implement.

”Regulatory authorities cannot easily respond to the pressures and demands of dynamically or rapidly changing economic conditions. A typical rate formulation can take at least six months to a year to complete. Traditional regulation also has bias towards capital investment, since return on rate base is the only profit-making opportunity for the regulated utility. One of the primary reasons that traditional regulation is not as efficient as competition is information asymmetry. Regulated utilities and the regulatory authorities do not adjust prices as quickly or as accurately open markets can” [1]. Restructuring and re-regulation require a new regulatory mechanism which is more quick, more responsive, more flexible, more transparent and easily perceived by the public and authorities.

Cost of service/rate of return regulation assumes a direct relation between the electric utilities’ prices and their costs. This relation is generally perceived as the basis of reasonable rates. Relating the utility’s prices to costs decreases the utility’s incentives to reduce the costs and increase market responsiveness, because income from these efforts will go largely to ratepayers, not to shareholders. The utility’s incentive for being innovative also diminishes as prices are based, not on the value, but only on costs. Also, prudence reviews might find some of these expenditures unnecessary. So, the utility’s gains from innovation are constrained with respect to its potential costs.

Cost of service/rate of return regulation will come up with many problems, while electric markets require more competitive behavior than before. Cost of service/rate of return regulation does not provide the regulated electric distribution utilities adequate pricing flexibility, which is necessary to give quick response to rapidly changing market conditions and to fulfill all part of its services. In order to give an example, unavailability of price flexibility causes some of the customers to select the other competitive suppliers, thus per unit cost for the remaining customers increases.

1.3.4.1. Incentives of The Traditional Regulation

The most objective way to perceive the incentives offered by cost of service/rate of return regulation is having the sufficient and deep understanding of how electric distribution utilities make money. The rate case step creates no powerful incentives. Rate cases have never completed determinations of the reasonableness of the costs, debates concerning the prudence of investments, and hidden rate of return debates over the costs of capital and its structure. It is believed that rate case decisions on cost, on the rate of return and on revenue requirements actually create some incentives for utilities, actually not.

The single conclusion about the rate case is setting the prices. In cost of service/rate of return regulation, once the rate case is fully completed and all prices are set, then electric utility profits are ruled by a simple formula:

$$\text{Profit} = \text{Revenue} - \text{Costs}$$

The revenue part is easy to calculate; the electric distribution utility's revenue is calculated by again a simple formula:

$$\text{Revenue} = \text{Price} \times \text{Quantity}$$

At cost of service/rate of return regulation, prices determined at the end of each rate case are constant until the end of the next rate case. As mentioned above, price is constant within this period, so total revenue is simply related to sales quantity. This means that the change ratio in revenue is equal to the change ratio in sales.

For electric distribution companies, the costs do not significantly change with sales. This has very strong and robust effect for electric distribution utilities' making money structure. According to the simple profit formula:

$$\text{Profit} = \text{Revenue} - \text{Costs}$$

Revenues are dependent to sales figures and whereas costs are almost independent of sales, which implies that profits and sales are directly proportional. For cost of service/rate of return regulation, this implies that increase in sales means increase in both revenue and profits, also decrease in sales means decrease in both revenue and profits.

With the help of above information, it is easily understood that main incentives of traditional cost of service/rate of return regulation as applied to electric distribution utilities are having volumetric prices and increasing sales. Naturally the most important disincentive is taking part in any activity that reduces sales. Because of the main characteristics of cost of service/rate of return regulation there is no incentive for cost reduction.

"Traditional cost of service regulation neither provides a guaranteed return, nor lacks incentive properties. Indeed cost of service regulation can provide very strong incentives. The question for regulatory authorities is whether a particular performance based regulation or other modifications to existing regulation practices yield desired results, such as economic efficiency, least cost service, environmental protection and better serve the greater public interest"[7].

1.3.4.2 Traditional Regulation Problems

Even though the public interest is served by traditional cost of service/rate of return regulation, there is a question whether it is still suitable for the current electric distribution utilities or not. The question is due to unavailability of strong incentives to reduce costs, unavailability of productivity improvement, costs of regulation, the tendency towards increased competition, and the related problems with mixing competition and regulation. Currently, because of the above reasons the regulation principle in electric distribution service is restructured, introducing competition into wholesale and retail electricity sales activities. It is anticipated that electric distribution wires business will remain to have its classic monopoly functions, but certain distribution functions will become competitive services.

The change in regulatory authority responsibilities, as well as the changes in energy market structure, mean that a new regulatory regime must be developed for application to the remaining monopoly functions of the utility.

CHAPTER II

PERFORMANCE BASED REGULATION

Performance based regulation is an alternative to traditional regulation within a more competitive electricity distribution service. Performance based regulation has moved from the academic world to the real world of regulation primarily by its adoption in the telecommunications industries in the United States and United Kingdom [16]. If it is properly and well designed, performance based regulation can provide better financial incentives than today. Regulatory authorities should be very careful while designing performance based regulation mechanisms to link long term public policy goals with short term profit incentives. Performance based regulation would give incentives to assure that programs to acquire resources are well designed to acquire the best resources from a long term least cost perspective using competitive processes in many cases. [25].

For electric distribution service, regulatory authorities consider performance based regulation as an alternative regulation mechanism to the traditional cost of service/rate of return regulation. Performance based regulation can provide better financial incentives for electric distribution utilities to lower electricity costs. It is flexible and market based, also can reduce oversight of the utility planning process and allow utilities to be cost and customer driven, rather than regulatory authority driven.

“The fundamental principle behind performance based regulation is that good electric distribution utility performance should lead to higher profits, and poor performance should lead to lower profits”[10]. Regulatory authorities identified a number of important aspects of good electric distribution utility performance as: providing electricity at low cost, maintaining a reliable supply of electricity service, improving customer efficiency, minimizing possible risks of cost increases and providing satisfactory customer services. Achieving these goals within an incentive regulation is a difficult issue, because the specific design of performance based regulation mechanism can have very different effects for different regulatory goals and electric distribution utility actions.

How should a performance based regulation mechanism be designed and applied in order to achieve the above goals will be discussed in this chapter. There are numerous items for providing incentives to lower short term electricity production costs and to ensure that those benefits are passed on to customers. There are also different options available for encouraging the acquisition of cost effective resources over the long term.

Some types of performance based regulation mechanisms can be applied to encourage the demand side management. Performance based regulation mechanisms can also be designed to encourage the electric distribution utilities to maintain or improve environmental protection activities.

2.1 The Goals of Performance Based Regulation

Performance based regulation is considered as a means of addressing some concerns about traditional regulation cost of service/rate of return regulation .The cost plus approach does not provide electric distribution utilities enough incentive to reduce the costs. Traditional regulation may not provide electric distribution utilities enough flexibility to undertake competitive initiatives, like offering discounts to the customers with demand elasticity.

Performance based regulation mechanisms provide electric distribution utilities with a fixed price or a fixed level of revenues, which is opposed to a predetermined level of profits. Electric distribution utilities can earn higher or lower profits associated with how properly they plan and operate their systems. Performance based regulation is more market based than traditional cost of service/rate of return regulation because electric distribution utilities are motivated by opportunities to increase their profits.

Performance based regulation should be designed to encourage electric distribution utilities to achieve some of the traditional regulation goals like providing reliable, least cost electricity and supplying service the customers in a indiscriminately manner. As the electric distribution gets more competitive regulatory authorities have to apply new approaches and new mechanisms for regulation. However the basic goals of the traditional regulation should remain same. The main goals of performance based regulation mechanism are as follows;

- The performance based regulation should provide electric distribution utilities with the financial incentives and the flexibility to reduce costs by operating as much as possible.

- The performance based regulation should provide economic efficiency by providing suitable pricing and incentives to maintain a high level of reliability and quality of service.

- The performance based regulation should protect customers' interests and yield reasonable prices.

- The performance based regulation should allow the electric distribution utility a flexibility to gain a reasonable return on shareholder capital and to maintain its financial integrity.

- The performance based regulation should provide electric distribution utilities with the flexibility to undertake innovative and competitive initiatives, including offering pricing flexibility or other electricity services to the specific customers with demand elasticity.

- The cost of implementing performance based regulation, including the regulated electric distribution utility and the regulatory authority, should not exceed the benefits resulted from performance based regulation.

- The performance based regulation should be flexible and adaptable to rapidly changing market conditions.

- The performance based regulation should be in comfortable with all the requirements of the legislation and regulations.

- The performance based regulation should be transparent.

- The performance based regulation should be simple.

- The performance based regulation should allocate the income fairly among the shareholders, electric distribution utility and the customers.

- The performance based regulation should make easier the use of efficient processes.

- The performance based regulation ensure that all customers and customer classes are treated fairly in a nondiscriminatory manner.

- The performance based regulation encourage electric distribution utilities to maintain a satisfactory level of customer services such as billing, metering and maintenance of the equipment.

- The Performance based regulation standards should be objective and easily measurable.

- The Performance based regulation should include both rewards and penalties.

It is difficult to achieve these goals with a single regulation mechanism; regulatory authorities must examine the performance based regulation proposals carefully in order to avoid the risk of over or under recovery costs or the creation of unnecessary incentives. Because of such a variety of goals, it is possible that performance based regulation will not reduce regulatory oversight completely.

The general consideration for regulating a more competitive electricity distribution service is to reduce the regulation pressure on the aspects of distribution service that are sufficiently competitive and to go on to regulate the aspects which is monopolistic or insufficiently competitive. Performance based regulation should be implemented to aspects of the electricity industry which is uncompetitive. These aspects will include distribution services depending upon the type, extent and timing of restructuring activities.

As implied by the goals listed above, performance based regulation has two general functions. "Performance based regulation should promote lower costs and efficient operations in the short term and it should encourage acquisition of cost effective resources over the long term"[11].

2.2. Cost and Efficiency Incentives

Performance based regulation mechanisms can be targeted to specific activities, or can be comprehensive, providing incentives for all aspects of electric distribution utility planning and operations. Comprehensive performance based regulation mechanisms receive most of the attention, because they provide electric distribution utilities with greater flexibility under increased competition.

The commonly issued comprehensive performance based regulation mechanism is the price cap regulation. The goal of price caps is to control electricity prices, as opposed to cost of service/rate of return regulation. Price cap is different from traditional regulation in two basic ways. Prices are put in place for longer period of time. The longer period of time is necessary to provide incentives to reduce costs. If the electric distribution utility can keep its costs below this predetermined price cap then it can get the difference as profits. If its costs increase above this predetermined cap then it has no profits. Also electric distribution utilities are allowed to lower their prices to some specific customers as long as all prices fixed within the price cap. This provides electric distribution utilities to make competitive price discounts to customers that might otherwise leave the electric distribution system.

A price cap starts with an initial rate for each customer class, based on a suitable allocation of costs. The price cap is then allowed to increase from year to year to allow for inflation rate, but is also required to decrease over time to encourage raise in productivity .The price cap formula is;

$$\text{Price cap }(t) = \text{Price cap }(t-1) \times (1 + I - PF) + Z$$

The Price cap (t) is the maximum price that can be charged to a customer classes for the current period, Price cap (t-1) is the average price charged to the same classes during the previous period, I is the inflation factor, PF is the productivity factor and Z symbolizes any incremental costs that are not subjected to the price cap.

2.2.1. Performance Based Regulation Scope Determination

Price caps can be implemented to customers as a complete or to individual classes of customers .More than one price caps implies a trade off to the regulatory authority for protecting the core customers which have no chance to select their electricity suppliers .A single cap on the other hand, would allow a electric distribution utility maximum flexibility to negotiate individual contracts. A price cap applied to all customer class prevents cost shifting among customer classes and provides greater protection for smaller customers.

2.2.2. Inflation Factor

Under traditional regulation, there is no explicit inflation adjustment for prices. Prices are fixed at the end of a rate case, and they remain at that level until changed at the end of the next rate case.

"Very essence of performance based ratemaking is tied to escalation factor. If a poor choice is made during its selection, the entire process and the future benefits of the utility and its customers could be in jeopardy. Set the escalator too high and rates go up and the rate of return escalates beyond the reasonable rate of return"[1].

During high inflation, rates may be initiated by electric distribution utilities quite frequently. During low inflation and high revenue growth, electric distribution utilities may not initiate a rate review for a decade or more. A goal of performance based regulation is to increase the incentive to cut costs. To accomplish this goal one needs to increase the duration of regulatory lag. The purpose of the inflation term is to allow the performance based regulation to have longer regulatory lag. If a performance based regulation has a positive adjustment for inflation, costs would grow faster than revenues and therefore a rate increase is required. On the contrary, if inflation is negative, it is because costs are expected to grow more slowly than revenue, a rate reduction will be required.

Use of a general inflation index such as consumer price index has the advantage from a customer standpoint of being well understood and closely related to the customer's general cost of living. But a general inflation index might not close relation to changes in an electric distribution utility's costs. In principle the inflation factor should be set exactly at the rate at which costs are growing in the electric distribution as a whole.

2.2.3. Productivity Factor

The productivity factor is an adjustment to the inflation factor. The importance of the productivity factor is in sharing the performance based regulation's benefits with consumers or pushing electric distribution utilities to improve productivity. The main purpose of the productivity factor is to adjust the inflation factor so that the resulting multiplier (I-

PF) produces a reasonable level of revenue growth or a reasonable level of anticipated cost growth. Performance based regulation approaches the issue by comparing trends in inflation indices to the electric distribution utility's total cost trends. This analysis identifies how utility costs are controlled relative to inflation.

"Choosing a productivity factor will have important implications for utility cost recovery, yet an appropriate level of improved productivity is not easy to define"[12]. In most cases, a productivity factor is based upon analyses of productivity gains by the electric distribution utility or by the electric industry itself. It can also be used to set objectives for the electric distribution utility.

2.2.4. Exclusions or Z Factors

Exclusions, called Z factors, are items excluded from the operation of the performance based regulation. Z factors usually include costs over which the utility has no control. Changes in taxes, changes in laws, changes in financial standards or catastrophic events are examples for Z factors. Z factors are used to allocate risks. Any cost associated to a Z factor means it is a cost, or a risk, that the utility cannot handle except obeying.

"The Z factor adjusts the price escalation for external developments that are not included in the escalation or productivity factors.These external developments,if not specifically taken into account,could reward or penalize the utility for events that are not under its control"[1].

"The Z factor criteria

- The event causing the cost must be exogeneous to the utility.
- The event must occur after implementation of the performance based regulation .
- The electric distribution utility cannot control the cost increase due to event.
- The costs are not related to a normal duties and activities of distribution business.
- The event affects the utility disproportionately.
- The performance based regulation update rule must not implicitly include the cost.
- The cost must have a major negative impact on the utility.
- The cost impact must be measurable.
- The utility must incur the cost reasonably"[13].

2.2.5 Profit and Loss Sharing

Price cap schemes can be combined with profit or loss sharing mechanism which are intended to protect both the electric distribution utility and ratepayers from the risk of over or under recovery of revenues. Sharing mechanisms kick in if the electric distribution utility earns above or below a specified interval around its allowed rate of return. High sharing fractions can allow for a utility's prices to better track the realized costs, which can improve allocative efficiency [23]. Broad intervals provide greater incentive for the electric distribution utilities to reduce their costs and narrow intervals decrease the possibility of the electric distribution utilities experiencing unexpected gains or losses.

2.2.6. Quality of Service

Regulator authorities are anxious that quality of electric distribution service can be a victim of performance based regulation because electric distribution utilities may cut corners or eliminate certain services in order to reduce costs and increase profits. This takes considerable attention from regulatory authorities in designing an effective performance based regulation plan. The common consideration is to define minimum service standards and impose penalties if standards are not met.

2.3. Evaluation of Performance Based Regulation

Like every regulation regime, performance based regulation have both benefits and drawbacks. Performance based regulation regime is benefical to customers and utilities, because it creates incentives to reduce costs, sets targets for efficiency and service quality,promotes the implementation of demand side management programs,creates incentives to implement reliability standars and improve employee safety rules, whereas in some situations it can be regarded as having some drawbacks like reduced costs may cause low level quality service, focusing on some incentives may cause little attention to other operations, productivity factor can be set to high, other utilities can take part in the market, cost reduction can cause insufficent reliability and safety operations.

CHAPTER III

PERFORMANCE BASED REGULATION MODELS

In this chapter, the most common performance based regulation models in electric distribution service will be discussed. Performance based regulation models are simple to understand and administer. Experience with real implementation in different countries stated that the simplicity could be deceptive. Incentives, limitations, standards, terms and sharing mechanisms should be carefully thought in design of performance based regulation. There are four main types of performance based regulation models, which have been widely implemented in practice:

- Price Cap regulation
- Revenue Cap regulation
- Sliding Scale regulation
- Yardstick regulation

The most common types of performance based regulation in use are price cap and revenue cap regulation models. For cap regulation mechanisms, changes in price indices drive reasonable changes in the output prices or revenue for the regulated electric distribution services. These permitted rates of change in price or revenue of the regulated service are decreased by productivity offsets that explains industry tendency and provides for productivity improvements. In order to implement an accurate price index and productivity factor, strong familiarity with price index and index calculation is required. A price cap regulation mechanism or a more improved industry based mechanism can be critically important. Confusion about the correct usage of productivity offsets has sometimes resulted in price cap regulations that distort the earnings of regulated electric distribution utilities.

Price and revenue cap regulation plans have potentially different incentives on pricing and sales strategies. However, they have generally similar incentives on costs. For price and revenue cap regulations, costs for unusual and unanticipated events which are not under the control of the electric distribution utility evaluated through a Z factor. Growth factors are included in revenue caps regulation.

The sliding scale model to performance based regulation sets caps on earnings beyond which excess earnings are shared between ratepayers and shareholders according to a predefined formula. The sliding scale model is the easiest of the four models that described, however the sliding scale model requires careful consideration of suitable threshold earnings level and split of excess earnings. The level of excess earnings at which sharing begins in between ratepayers, shareholders and the quantity of sharing can effect electric utilities' decisions and investment strategies. The earnings sharing mechanism in performance based regulation plans can act as a stopper in the event the performance based regulation plan results in unpredicted earnings.

Benchmark or Yardstick regulation basically uses data on electric industry and group cost performance to form a benchmark price for each electric distribution utility in that group. Most Important criteria in implementing yardstick regulation is the need that each electric distribution utility be benchmarked against a group of similarly situated and structured electric distribution utilities. If not, inconsistent comparisons due to main cost differences could cause inequities in forming benchmark prices.

The Regulatory authorities are in doubt with performance based regulation plans to the extent that they might encourage excessive or inconsistent cost cuttings unless firms are forced to consider appropriate service and quality standards. Performance based regulation should explicitly account for productivity incentives by connecting allowed returns to several areas concerning the service quality and service reliability standards. While this model can be data intensive, in that it usually requires developing electric distribution service and performance, it can make sure that performance based regulation induced gains in cost and efficiency do not come with related reduction in service quality, service reliability, or service safety. It also requires careful consideration of the reasonable increases or decreases in returns resulting from performance against these benchmarks.

Some performance based ratemaking plans combine aspects of these models, creating a mechanism to better perform regulatory objectives and concerns. Price cap plans can be constructed to include earnings sharing and performance standards. Performance based regulation implementation will indicate that the growing concerns of regulatory authorities will require performance, quality, and service standards be included in electric distribution utilities' operations.

3.1. Price Cap Regulation

In price cap regulation the prices are capped independent of the costs. The test year's price caps are set to the price of the previous year indexed by an inflation factor offset and by a productivity factor. Extraordinary events are taken into account in determining the price cap.

Price cap is the type of regulation that focuses initially on controlling the prices directly, rather than indirectly as the cost of service/rate of return regulation does. Under cost of service/rate of return regulation an electric distribution utility's prices are the result of controls on the cost based revenues .The allowed rate of return fixes the profits together with expenses, forms the electric distribution utility's revenue requirement. Prices are then calculated as the revenue per unit of energy sold.

As time passes, deviations in real profits may lead to adjustments in prices towards the end. While some restrictions on profits may limit actual returns significantly above or below the anticipated return in the plan, within these upper or lower bounds the utility has flexibility to set or change prices as long as the resulting price satisfies the price cap limitations in the plan. Therefore, the electric distribution utility has an incentive to operate more efficiently, because costs savings, new services or greater market responsiveness which increase the electric distribution utility's profits can be retained by the utility subject to the limitations in the plan. Price cap plans actually works in this manner. After initialization of the rates, a price cap regulation plan provides for the periodic adjustment of the prices much as in a competitive market. In a competitive market, changes in the fuel prices purchased by the generation firms tend to be passed through to customers to the extent that improvements in operating efficiencies cannot offset such changes. In a price cap plan, adjustments to cap or ceiling prices are determined by an index, which simulates the competition market structure .The changes in input prices cause changes in productivity. Therefore high price inflation index increases the output price cap and high productivity factor lowers the output price cap.

Price cap plans use a number of price indices to represent fuel price inflation. The index should represent the change in fuel prices with the labor and capital values purchased by the utility are added. Tradeoffs exist among the potential inflation indices. Regularly published government price indices may not include all the variables that reflect the price changes in the electric industry. If published, the inflation indices are generally released with a substantial time lag. Regularly published government price indices, which are released on a timely basis, may be fully not suitable for electricity prices due to fact that they mainly focus on consumer purchases or other economic measures.

While designing a price cap from the existing input price index options, such considerations must be carefully taken into account. Stakeholders must be confident that the measure is accurate, on time and cost effective. Detailed research may be required to form a specific price index for each regulated electric distribution utility to make it certain that published price indices are reliable.

Real price cap plans utilize many models to determine the changes in productivity factor among the regulated electric distribution utilities. Sometimes a negotiation process is used; sometimes-official statistical measures provide the necessary information. In some situations, information from electric distribution utilities is used to evaluate the previous or anticipated progress in productivity. Actually price cap regulation plans utilize many models for determining the size of the productivity offset. Like the price index situation, tradeoffs also exist among these models. The productivity offset should be accurate, on time and cost effective, therefore it should be carefully calculated. It is noted that the actual productivity offset used should be based on group performance, not based on single electric distribution utility's performance.

An electric distribution utility that develops its productivity more than the group standard, which is expected in the price cap regulation plan can retain the increased earnings related with its high performance. Because each electric distribution utility wants to improve its productivity performance relative to group average; if adequate time is paid, the rate of productivity change should increase during the lifecycle of the plan.

Implementation of a price cap regulation model to electric distribution utilities may have two main drawbacks, which must be carefully taken into account. Both of these drawbacks have a tendency to decrease in revenue cap regulation plans.

First drawback is that price cap regulation plan tends to provide increment in sales by the electric distribution utility because of prices, not quantities. This incentive, in some situations, may not be appropriate with energy efficiency goals. Such incentives to increase sales can be lowered through a plan design features. An earnings sharing mechanism reduces the electric distribution utility's incentive to increase profits. Therefore, not specifically designed for this issue, earnings sharing mechanism could be used in combination with price caps. Regulatory authorities could include energy efficiency goals, which reduce sales quantities and their related rewards or penalties among the performance standards in the price cap regulation plan.

Second drawback is that price cap models may be less appropriate in cases, where the regulated electric distribution utility has high fixed costs and comes up with instability in revenues not under its control. For the electric distribution utilities under price cap regulation, significant decreases in energy outputs can result in revenue shortfalls, without related decrement in the distribution costs.

3.2. Revenue Cap Regulation

In a revenue cap regulation the test year's revenue is capped independent of the electric distribution utility's costs and is set according to the previous year's revenue indexed by an inflation factor adjusted by a productivity factor. Unusual, extreme events and growth are included into the revenue cap regulation model.

Revenue caps are similar to price caps, except that revenue is adjusted by changes in input prices net of changes in productivity. In some revenue cap regulation plans, allowed revenue is also adapted to reflect changes in the number of customers. The incentive provided a regulated electric distribution utility to reduce costs under a revenue cap is as same as the incentive provided by a price cap regulation. Also all of the issues related with price caps with respect to price indices, productivity offsets, standards, sharing and term hold for revenue caps.

Actually revenue caps differ from price caps in diminishing both the incentive and risk related with sales. Because under revenue cap regulation an electric distribution utility's allowed revenue is constrained, the electric distribution utility's incentive is to diminish not only unit costs but also the number of units sold such that total profits are get higher. Therefore, revenue cap regulation may be more compatible with energy efficiency programs, which try to reduce demand, than are price cap regulation.

Fluctuations in sales due to factors that are not under the control of utilities may not cause the electric distribution utility to suffer severe financial problems.

Pricing feature of revenue caps is criticized because it encourages the electric distribution utility to increase its prices, so decreasing sales to stay within the revenue cap and maximizing profits. Other criticisms state that price cap regulations are more efficient in setting relative prices and that pricing in revenue cap regulation is more variable. Therefore it is offered to combine properties of both price cap regulation and revenue cap regulation to offset the relative disadvantages of each regulation model separately. Therefore, It may be specified that a revenue adjustment within a price cap regulation or a price adjustment within a revenue cap regulation.

3.3. The Sliding Scale Regulation

Sliding scale regulation mechanisms follow the electric distribution utility's actual profits and share with ratepayers some or all of the earnings that fall below or above certain plan levels. The zone between these levels is termed a dead band and the electric distribution utility and its shareholders are at risk for results, which are in this zone. Under sliding scale regulation, prices are adjusted to keep a utility's rate of return within or close to a dead band. Next to an explicit adoption of regulatory authority lag; types of sliding scale regulation were some of the earliest forms of incentive regulation [19]. Dead bands are formed to maximize the electric distribution utility's eager and incentive. Earnings above or below these levels are shared with ratepayers under various pay out formulas. If earnings become too large, rates are cut and if earnings fall too low rates are increased [20]. Performance, which is outside of the dead zone, may start automatic reviews.

Earning's sharing is often associated with the performance based regulation models or with other incentive modifications to a cost of service/rate of return regulation models. Earning's sharing has been used together with a rate freeze to electric distribution utilities under cost of service/ rate of return regulation.

Regulatory authorities must compensate the electric distribution utility's reduced incentive and eager as a result of sharing with the greater insurance against undesirable outcome. While the earning sharing mechanism may decrease the electric distribution utility's incentive and eager by reducing its reward, it can also act as a stopper for inefficiencies in regulation plan design or implementation.

High earnings could be due to poor plan design that rewarded like superior performance. Even if deserved, high earnings can still cause a perception problem, reduce commitment, and cause regulatory authority backlash. Poor performance can undermine an electric distribution utility's responsibility to quality and reliability standards and even to the concept of performance based regulation itself. Regulator authorities should find a suitable way that consistently balances incentives and self protections, particularly in the initial stages of implementation.

3.4. The Yardstick Regulation

In order to regulate large number of electric distribution utilities, which have similar technology for electric distribution service and are servicing for dissimilar markets; like residential, industrial or commercial; the yardstick regulation model can be applied. The main concern of yardstick regulation model is the use of consistently partitioned groups' cost and performance measures to form external similar group benchmarks. Yardstick indices are of particular value when several regional utilities have cost characteristics that are correlated with each other [22]. Electric distribution utilities can be partitioned into groups with respect to their sizes or their market place, where they operate like rural or urban areas.

A special case of yardstick regulation is benchmarking based on a hypothetical efficient company [4]. The optimal cost level for a regulated company is calculated through engineering economic analysis by defining a model utility or model network in the case of distribution business [27].

If the external benchmark were done for the average cost of the same group, then each electric distribution utility charge an average price equal to the same group's average cost. As a result every electric distribution utility has a strong incentive and eager to reduce its costs, while doing this electric distribution utility's profits will increase with respect to the price cap set on the group's average cost.

In the long run, efforts by each electric distribution utility to become more efficient would result in reduction in costs and as result reductions in the price caps. Each electric distribution utility would have an incentive and an eager to service new customers, for to increase the number of customers; to serve or implement innovative services if the related extra activities increase earnings.

Yardstick regulation model to performance based regulation wants to set up an efficiency competition within the same group of regulated electric distribution utilities. Every electric distribution utility is pushed to compete with respect to efficiency and responsiveness. While designing yardstick regulation, it is important that the simulated competition should be between similarly structured electric distribution utilities. It is necessary to control for main differences in cost conditions between electric distribution utilities. These main differences of electric distribution utilities are size, number of customers they serve, customer density and end user load characteristics. These main differences would predictably remain even if all electric distribution utilities operated at maximum efficiency. Therefore, these main differences need to be well clarified and controlled by the careful selection of benchmark groups and assignments.

Main cost differences are included in the yardstick regulation model by a multi phased application process that places every electric distribution utility in a competition with similarly structured electric distribution utilities.

In order to establish competition , the following steps must be completed;

- All electric distribution utilities should give adequate information on their costs, market and customer profiles, rates, operations and revenues.
- Statistical modeling of above information should identify and quantify main cost differences. Expert committee judgment can be used as an alternative or to confirm the results of the statistical analysis. Results of identifying main cost characteristics can be used to form a set of benchmark group classifications.
- The benchmark group characteristics defined can be implemented to the information provided by every electric distribution utility to form benchmark group assignments for all electric distribution utilities.
- Information obtained about costs, market and customer profiles, operations, revenues and rates should be used to calculate average costs for every benchmark group. These average costs calculated by every benchmark group would be formed as external benchmarks for each electric distribution utility's average price.

Updated information should be collected to form new group benchmarks and measure performance of yardstick regulation model. This must be done periodically and the regulatory authority must determine the period duration.

It would be useful to reexamine each electric distribution utility's benchmark group assignment to be sure that structural changes in electric distribution utilities' markets, customers, or operations were suitably mentioned in benchmark group assignments. It is also beneficial to reexamine the identified main cost characteristics and the benchmark group classifications periodically.

CHAPTER IV

IMPORTANT ITEMS FOR APPLICATION OF PERFORMANCE BASED REGULATION

Performance based regulation is viewed as a simpler, less costly, and more transparent form of regulation than cost of service/rate of return regulation. But there are many critical issues in implementing a performance based regulation plan. Actually achieving the benefits of performance based regulation is not simple or easy.

4.1. Internal Factors

The most important issue in implementing performance based regulation is the process of setting initial rates. Initial rates should be reasonable and equitable and allow the electric distribution utility a suitable return.

Application problems occur in situations, where the performance based regulation is implemented together with privatization or where current rates had been set sometime previously and rapid technological changes had undermined the connection between rates and returns.

Electric distribution utilities subjected to performance based regulation want more frequent and detailed reviews. This reveals unexpected over earnings and it is followed by repeated increases in the productivity factor. “Both the United Kingdom and the United States telecommunications regulatory authorities increased the plans' productivity factors by more than 100 percent over a series of adjustments"[9].

Lags in regulatory authority adjustments to the performance based regulation plans' parameters necessitates almost continuous progress to develop accurate actions. "For United Kingdom electric distribution companies, the government ultimately applied a retroactive windfall profits tax"[9].

Better understanding of the details and potential biases of performance based regulation adjustment formulas will reduce most of the application problems. The early implementation of performance based regulation plans often failed to specify standards for quality, service, and safety. Increment in profits is believed to be based on cuts in important service, quality and safety standards. This causes significant rethinking in following performance based regulation applications. Actually, regulatory authorities must be aware of setting incentives for electric distribution utility's behavior within the set of opportunities which are consistent with regulatory objectives and obligations.

Regulatory authorities must balance increased incentive on the part of the electric distribution utility with suitable regulatory authority review of the electric distribution utility's performance in determining the performance based regulation plan's term. Frequent reviews decrease the electric distribution utility's incentive to improve standards because these improvements become the basis for updated performance benchmarks.

The term is an important attribute of a performance based regulation plan. During the term of the plan, the utility has the opportunity to capture the benefits of productivity improving investments. When terms are short, utilities become subject to the effect, under which they will not even try to make a cost effective investment, because they may not recoup their productivity improving investment and will have to try harder in the future just to break even [21].

Price cap plans with very short time tend cost of service/rate of return regulation with little regulatory lag. A well organized plan duration allows electric distribution utilities to utilize from the operating efficiencies, for which they take the responsibility; at the same time it permits the regulatory authority to measure the effectiveness of the plan either in whole or in part.

Performance based regulation plans should also identify what events are to be considered as unpredicted or unanticipated events. These unanticipated events are called Z factors, which relax the limits imposed by price, revenue or earnings constraints.

4.2. Economic Factors

Not understanding the economy, industry, and geographic market environments may cause unanticipated results. Regulatory authorities should design plans designs that are consistent to the characteristics of the electric distribution utility and the time of the application. Some regulatory authorities react to the profit problem by setting the productivity factor at potentially high levels. Imposition of high productivity factors in periodic terms results in a worsening of financial results when the electric distribution utility's high observed productivity growth is based on general economic conditions, rather than the management induced efficiencies. Not be able to recognize differences in productivity growth among different systems or at different points in economic cycles may lower the benefits in the long run.

4.3. Plan Flexibility

Regulatory authorities have to rapidly take a dynamic view of industrial, technological, and regulatory changes. Not being able to correctly predict the nexus of such issues, reduces the effectiveness of the transition.

The performance based regulation plan design requires handling suitable current and potential competitive services. For instance electric distribution market may offer competitive services, including meter reading and equipment servicing. Some industry analysts predict a time when electricity distribution utilities will have the technical capability to offer telephone signals over their wires as one of the major competitors to local phone companies.

Restructuring of these innovative service offerings, convenient cost allocation between traditional regulated services and new services become more critical issues. The performance based regulation plan should permit electric distribution utilities to take the responsibility of investments and offer new services easily adaptable for changing technologies, market structure or customer profiles. At the same time, it should allocate the cost and risk of innovative investment appropriately.

4.4. Competitive Effect

The performance based regulation plan needs to consider the impact that it may have on the competitive balance among industries. The competitive balance between the industries should shift in response to the fundamental economics of the industries; it is not so easy to detect whether shifts in market share are due to basic changes in economics or whether the shift is driven only by performance based regulation design. Therefore, effects of the performance based regulation design on competition between industries should be evaluated.

CHAPTER V

QUALITY IN ELECTRIC DISTRIBUTION SERVICE

Regulatory authorities have eager to implement appropriate techniques in electricity distribution service to minimize the negative effects of cost reductions generated from regulatory models used to control electricity distribution service. Quality aspects are increasingly arisen due to growing interest from the customers.

5.1. Regulations on Quality

Quality requirements for electricity are so important for customers, regulatory authorities and electric distribution utilities. Some industrial steps suffer due to electricity outages. Like the industrial requirement, the quality demand in electric distribution service for residential customers also become important. Therefore, regulatory authorities should consider quality aspects carefully when implementing regulatory measures for electricity distribution service.

The methods used for performance based regulation can require a specific regulations on quality. The liberalization of energy markets has changed the need to regulate electricity distribution service. Performance based regulation methods are very popular among regulatory authorities. These methods have strong incentives to reduce costs. Reducing costs may influence the quality of electricity negatively. This is a great challenge for the regulatory authorities to implement an appropriate method to minimize the effects of cost reductions. Power quality issues have to be recognized in other regulation methods as well. The regulatory authority cannot rely on the engineering basics of the electric distribution utilities. There is a strong incentive to over invest and this does not lead to optimum level concerning quality and efficiency. High quality level requires high costs and hence high tariffs for electricity distribution service.

Regulatory authorities should own monitoring responsibilities relating to quality of electricity. “The regulatory authority has to provide adequate economic incentives for the maintenance and construction of the necessary network infrastructure”[14]. Quality of electricity distribution regulation can take many forms. Quality standards are in place. There can be penalties if these standards are not met. Financial results are also serious. In performance based regulation the incentive to improve quality level can be focused on the allowed revenue.

The goal of quality regulation is to make sure that the improvements of the distribution system is focused on the most rational targets. This requires the consideration of quality issues extensively, hence all perspectives are considered. Regulatory authorities come up with challenging issues for implementing quality incentive schemes. Different customers classes in electricity distribution business have different needs and therefore they evaluate quality in different ways.

There are four main counterparts in electricity distribution business, the customers, utilities, owners and the regulatory authority. The utilities perform their duty with respect to the profit requirements from utilities’ shareholders as well as different requirements of the customers and the regulatory authority. The Customers expect a certain quality level with reasonable prices. The regulatory authority works on behalf of these customers.

The regulatory authority aims reasonable tariffs while maintaining the quality of electricity at a certain level by designing regulations on the performance of the electric distribution utilities. These regulations include improvements to decrease costs and hence reduce tariffs. Certain quality level is achieved by required investments in the distribution service. "Member States may impose on undertakings operating in the electricity sector, in the general economic interest, public service obligations which may relate to security, including security of supply, regularity, quality and price of supplies and environmental protection. Such obligations must be clearly defined, transparent, non discriminatory and verifiable"[14].

The regulatory authority should determine the certain level of quality and give the electric distribution utilities incentives to invest in order to meet this level.

Regulations on the quality of electricity should emphasize on the items that are influential on the customers' equipment and also on the guidelines for the electric distribution utilities show to control them. By implementing these regulations, an optimum point that satisfies these two conditions is reached.

The regulation on the quality should be feasible; as well as providing measures how to measure it by the regulatory authority. Regulatory authorities have many alternative techniques to evaluate the quality level.

Regulations on quality are built up in different aspects: commercial relations between the customer and the electric distribution utility, voltage quality and continuity of supply.

5.2. Service Quality

Service quality is associated with service provided by the electric distribution utilities to the customers. Service quality is evaluated through standards defined by the regulations. Standards set the minimum service level that must be satisfied in each case. In case that the electric distribution utility fails to satisfy these standards, compensation should be paid to the influenced customers. Standards include:

- Service coverage
- Required performance level
- Penalty to be paid for the customers influenced

There are also some extra standards concerning the electric distribution service such as the longest time duration allowed for a repair activity, where it is not easy to specify standards but electric distribution utilities are expected provide a satisfactory performance. These kinds of standards generally do not include penalty payments but are used for assessing the performance of the utility.

5.3. Technical Quality

Technical quality generally includes voltage magnitude, frequency, voltage dips and harmonic distortion. There are many standards for technical quality. Technical quality is a highly influencing factor on the customer equipment to perform properly.

In principle, technical quality is determined in terms of the deviations of voltage provided at the customer terminals from the normal level. A voltage is said to have quality if it does not deviate from the nominal level by certain percentages. For most customers these percentages are defined as plus or minus 10% deviation from the nominal voltage.

Effects of under voltage;

- Weak illumination
- Speed drop in electrical machinery
- Destruction of the windings in electrical equipment due to overheating (Loss of production quality)

Effects of over voltage ;

- Destruction of customer's valuable equipment and property
- Fire risk
- Fatal risk
- Over speed in electrical machinery
- Loss of production quality
- Reduction in the lifetime of electrical/electronics equipment

The frequency is the number of full cycles within one second time. The frequency quality is directly related to the generation side(in Turkey TEIAS) not to distribution side.

Effects of under or over frequency in electric system;

- Speed of AC machinery directly depends on frequency
- Under or over frequency result in either speed drop or rise in AC machinery, leading to loss of production quality or interruptions.

The standards are in use for low and medium voltage distribution systems. Penalties should be imposed to those utilities, which fail to meet these standards. Technical quality is difficult to measure reliably and economically, so it is rather difficult to specify a practically applicable performance index for technical quality.

5.4. Continuity of Electric Service

Continuity of electric service to customers is a highly important attribute of quality. It is measured as the number, power shed and duration of interruptions in the region, where electricity distribution service is maintained. The regulatory authority should specify the regulations for the continuity of electric service.

Interruption is discontinuity in electric service. Interruptions in electric system causes fire risk, fatal risk, crime risk, productivity loss, production quality loss and destruction of the consumer equipment.

Interruptions are classified as ;

- Programmed interruptions
- Involuntary interruptions: power failure, voltage reduction.

The main continuity aspects are;

- Interruption type: planned or unplanned.
- Duration of interruption. Interruptions over 3 minutes are considered as long interruptions and the others as short interruptions.
- Measuring factors for continuity of service; such as the number, power shed and durations of interruptions. System Average Interruption Duration Index (SAIDI) that indicates how long energy is not supplied during a year, System Average Interruption Frequency Index (SAIFI) that indicates how many outages customers have in a year. Customer Average Interruption Duration Index (CAIDI) and Momentary Average Interruption Frequency Index (MAIFI). One of the most meaningful indices is to calculate the total amount of energy shed in a year in the region, by multiplying the duration of interruption with the amount of power shed in a year.

The regulatory authority sets targets for electric distribution utilities, concerning interruptions in terms of number, duration, power and energy shed. The regulatory authority narrows upper limits defining the conditions on these targets progressively. These targets define penalties and incentives to improve the quality of electricity.

Penalty payments made by the utility to the customers may have a significant effect on the electric distribution utilities in improving the quality. In general there is a strong correlation between the rate imposed to the customers and electric energy continuity. Hence it is possible to design some special recovery plans are possible for the electric distribution utilities to achieve a certain level of quality.

5.5. Quality Incentives

Quality incentives relate, the quality of the electric service provided by the electric distribution utilities to its earnings. The regulatory authority should determine the issues, on which the optimum quality level is achieved while maintaining the rate at a reasonable level.

The quality level can be measured at different levels from system quality level to the quality level provided to the single customer. According to the electric distribution utility performance with respect to the optimum quality level, reward or penalty terms should be applied to the utility. The penalties or rewards should be given as a ratio from the electric distribution utility ’s revenue or profit.” Penalties are usually carried out as price reductions to the customers”[15].

CHAPTER VI

PBR APPLICATION IN TURKEY

6.1. Electric Structure in Turkey

Electric market is one of the rapidly growing area in Turkish economy. Its total revenue is approximately 12 billion US$ per year. Recent years it was growing with the average rate of %8.As a result increasing electric consumption demand, increases the share of electric sector at Turkish economy significantly. Increment rate of electric consumption in Turkey is rapidly rising with respect to other industries growth rate and also Turkish economy growth rate itself. In 2003 total electric consumption was 145 billion kWh gross and 111 billion kWh net. In 2004 total electric consumption was 151 billion kWh gross and 121 billion kWh net. Industrial customers makes the half of the consumption (59 billion kWh). Residential customers were in the second place with the %23 consumption rate (27,6 billion kWh). In third place commercial customers exist with the %13 consumption rate (15,6 billion kWh).

In 2004 electric distribution system loss and leakage was around 19.7 billion kWh(%19), which is too high with respect to international standards.With well designed Performance based regulation loss and leakage ratio can easily decrease to very low levels.

Table 6.1. Electric Consumption(**Mwh**) in 2002/2003/2004 in Turkey

	2002	2003	2004
RESIDENTIAL	23 559 425	25 194 895	27 618 960
COMMERCIAL	10 867 292	12 871 904	15 656 151
PUBLIC	4 580 529	4 554 049	4 530 734
INDUSTRY	50 489 392	55 099 186	59 565 929
OTHERS	13 451 224	14 046 032	13 770 078
TOTAL	102 947 862	111 766 067	121 141 852
LOSS AND LEAKAGE	19 630 240	20 410 020	19 674 189

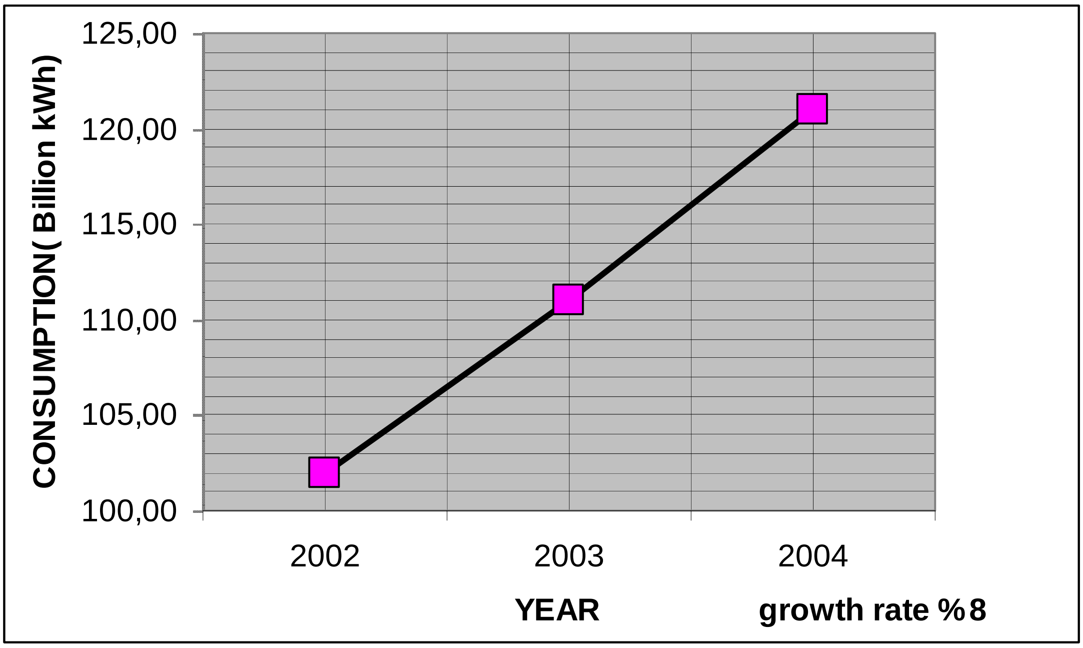

Figure 6.1. Total Electric Consumption in Turkey(2002/2003/2004)

6.2. Electric Distribution System in Turkey

In Turkey electric distribution is regulated by Electric Market Regulation Commission. It regulates 21 electricity distribution companies.5 of them are in operation since 13.03.2003. Licenses of 16 new electricity distribution companies were approved on 01.09.2006.

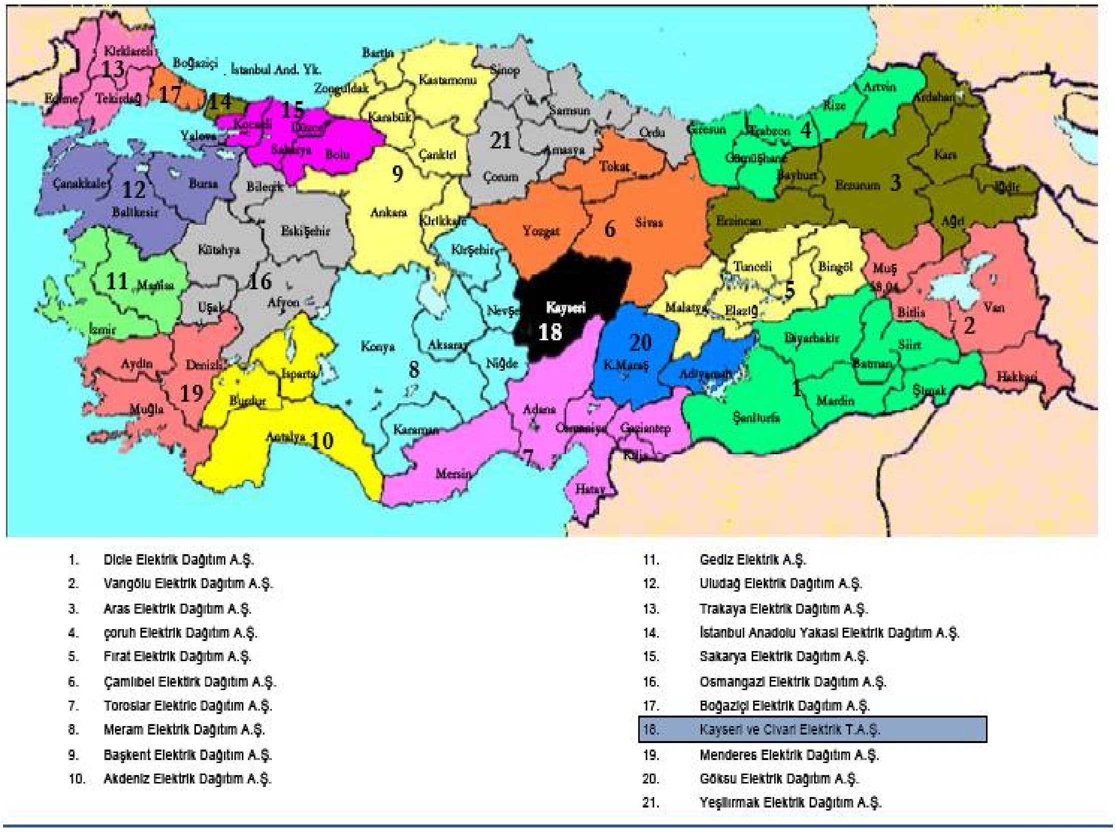

Figure 6.2. Electric Distribution Regions in Turkey

Table 6.2. Electric Distribution Utilities in Turkey

	COMPANY NAME	REGIONS	LICENCE DURATION
1	Başkent Electricity Distribution Company	Ankara, Kırıkkale, Çankırı, Karabük, Kastamonu, Zonguldak, Bartın	(1.9.2006- 30 years)
2	Boğaziçi Electricity Distribution Company	İstanbul European Side	(1.9.2006- 30 years)
3	Meram Electricity Distribution Company	Konya,Aksaray,Karaman,Niğde, Nevşehir,Kırşehir	(1.9.2006- 30 years)
4	Sakarya Electricity Distribution Company	Kocaeli,Düzce,Sakarya,Bolu	(1.9.2006- 30 years)
5	Trakya Electricity Distribution Company	Tekirdağ,Kırklareli,Edirne	(1.9.2006- 30 years)
6	Kayseri Electricity Distribution Company	Kayseri	(1.9.2006- 30 years)
7	Akdeniz Electricity Distribution Company	Burdur, Antalya, Isparta	(1.9.2006- 30 years)

Table 6.2. continue…

8	Aras Electricity Distribution Company	Erzincan, Bayburt, Erzurum, Kars,Ardahan, Iğdır, Ağrı	(1.9.2006- 30 years)
9	Çamlıbel Electricity Distribution Company	Sivas,Yozgat,Tokat	(1.9.2006- 30 years)
10	Çoruh Electricity Distribution Company	Giresun, Trabzon, Gümüşhane, Rize, Artvin	(1.9.2006- 30 years)
11	Dicle Electricity Distribution Company	Diyarbakır Batman, Siirt, Şanlıurfa, Mardin, Şırnak	(1.9.2006- 30 years)
12	Fırat Electricity Distribution Company	Malatya,Elazığ,Tunceli,Bingöl	(1.9.2006- 30 years)
13	Gediz Electricity Distribution Company	İzmir, Manisa	(1.9.2006- 30 years)
14	Göksu Electricity Distribution Company	Kahramanmaraş, Adıyaman	(1.9.2006- 30 years)

Table 6.2. continue…

15	İstanbul Electricity Distribution Company	İstanbul Anatolian Side	(1.9.2006- 30 years)
16	Menderes Electricity Distribution Company	Aydın,Muğla,Denizli	(1.9.2006- 30 years)
17	Osmangazi Electricity Distribution Company	Uşak,Afyon,Kütahya,Bilecik,Eskişehir	(1.9.2006- 30 years)
18	Toroslar Electricity Distribution Company	Mersin,Adana,Osmaniye, Gaziantep,Hatay	(1.9.2006- 30 years)
19	Uludağ Electricity Distribution Company	Çanakkale,Balıkesir,Bursa,Yalova	(1.9.2006- 30 years)
20	Vangölü Electricity Distribution Company	Muş,Bitlis,Van,Hakkari	(1.9.2006- 30 years)
21	Yeşilırmak Electricity Distribution Company	Sinop,Samsun,Ordu,Amasya, Çorum	(1.9.2006- 30 years)

6.3. PBR application for Sakarya Distrubution Company

Sakarya electric distribution company is one of the electric distribution companies, which includes Kocaeli ,Sakarya,Bolu and Düzce regions.

The effect of performance based regulation to those regions was investigated .

6.3.1. Kocaeli PBR application for 2000 and 2001

For the year 2000, Kocaceli region's electric consumption rates were investigated .For the year 2000 total spent money for electric consumption is 104.864.608 YTL and total consumed energy is 2.6 billion kWh.

Table 6.3. Kocaeli Region year 2000

Year 2000 without PBR			
ENERGY	**QUANTITY(kWh)**	**UNIT PRICE(YTL/kWh)**	**Total Price(YTL)**
SUPPLIED TOTAL ENERGY	**3.069.377.000**		
TOTAL ENERGY SOLD	**2.660.028.000**		
Residential	603.881.000	0,039304	23.734.939
Commercial	154.841.000	0,051346	7.950.466
Public	128.073.000	0,051346	6.576.036
Industry	1.481.474.000	0,038725	57.370.081
Agriculture	3.819.000	0,02415	92.229
Lighting	3.009.000	0,039304	118.266
Others	223.819.000	0,040312	9.022.592
Without price	61.112.000		

Table 6.3. continue…

TOTAL	2.660.028.000		**104.864.608**
SYSTEM LOSS AND LEAKAGE	409.348.000		
ratio %	13,34		

The application of performance based regulation for year 2000 ,with taking consumer price index 0.52 , productivity factor 0,47 and effect of performance base regulation 0,1 yields below results.

Table 6.4. Kocaeli Region year 2000 PBR applied

Year 2000 PBR applied			
ENERGY	**QUANTITY(kWh)**	**UNIT PRICE(YTL/kWh)**	**Total Price(YTL)**
SUPPLIED TOTAL ENERGY	**3.069.377.000**		
TOTAL ENERGY SOLD	**2.660.028.000**		
Residential	603.881.000	0,0373388	22.548.192
Commercial	154.841.000	0,0487787	7.552.943
Public	128.073.000	0,0487787	6.247.234
Industry	1.481.474.000	0,03678875	54.501.577
Agriculture	3.819.000	0,0229425	87.617
Lighting	3.009.000	0,0373388	112.352
Others	223.819.000	0,0382964	8.571.462
Without price	61.112.000		
TOTAL	**2.660.028.000**		**99.621.377**
Productivity Factor(PF)	**Consumer price index(CPI 1999)**	**PBR gain**	
0,47	0,52	0,1	

With applying performance based regulation ,it is predicted that approximately 5 million YTL might be have been saved in 2000. This saved money is shared between ratepayers,shareholders ,investors and also used for quality investments .

For the year 2001, Kocaceli region's electric consumption rates were investigated .For the year 2001 total spent money for electric consumption is 223.386.622 YTL and total consumed energy is 2.7 billion kWh

Table 6.5. Kocaeli Region year 2001

Year 2001 without PBR			
ENERGY	**QUANTITY(kWh)**	**UNIT PRICE(YTL/kWh)**	**Total Price(YTL)**
SUPPLIED TOTAL ENERGY	**3.226.030.000**		
TOTAL ENERGY SOLD	**2.699.068.000**		
Residential	539.073.000	0,083104	44.799.123
Commercial	160.860.000	0,098962	15.919.027
Public	187.872.000	0,098962	18.592.189
Industry	1.663.073.000	0,081943	136.277.191
Agriculture	3.769.000	0,050004	188.465
Lighting	2.358.000	0,083104	195.959
Others	94.784.000	0,078227	7.414.668
Without price	47.279.000		
TOTAL	**2.699.068.000**		**223.386.622**
SYSTEM LOSS AND LEAKAGE	**526.963.000**		
ratio %	**16,33**		

The application of performance based regulation for year 2001 ,with taking consumer price index 0.60 , productivity factor 0,48 and effect of performance base regulation 0,14 yields below results.

Table 6.6. Kocaeli Region year 2001 PBR applied

Year 2001 PBR applied			
ENERGY	**QUANTITY(kWh)**	**UNIT PRICE(YTL/kWh)**	**Total Price(YTL)**
SUPPLIED TOTAL ENERGY	**3.226.030.000**		
TOTAL ENERGY SOLD	**2.699.068.000**		
Residential	539.073.000	0,08144192	43.903.140
Commercial	160.860.000	0,09698276	15.600.647
Public	187.872.000	0,09698276	18.220.345
Industry	1.663.073.000	0,08030414	133.551.647
Agriculture	3.769.000	0,04900392	184.696
Lighting	2.358.000	0,08144192	192.040
Others	94.784.000	0,07666246	7.266.375
Without price	47.279.000		
TOTAL	**2.699.068.000**		**218.918.889**
Productivity Factor(PF)	**Consumer price index(CPI 2000)**	**PBR gain**	
0,48	0,6	0,14	

With applying performance based regulation ,it is predicted that approximately 4,5 million YTL might be have been saved in 2001.

6.3.2. Sakarya PBR application for 2000 and 2001

For the year 2000, Sakarya region's electric consumption rates were investigated .For the year 2000 total spent money for electric consumption is 33.545.818YTL and total consumed energy is 0,8 billion kWh.

Table 6.7. Sakarya Region year 2000

Year 2000 without PBR			
ENERGY	**QUANTITY(kWh)**	**UNIT PRICE(YTL/kWh)**	**Total Price(YTL)**
SUPPLIED TOTAL ENERGY	**981.356.000**		
TOTAL ENERGY SOLD	**806.159.000**		
Residential	281.924.000	0,043134	12.160.510
Commercial	132.772.000	0,051346	6.817.311
Public	29.337.000	0,051346	1.506.338
Industry	238.298.000	0,042512	10.130.525
Agriculture	2.195.000	0,02415	53.009
Lighting	2.532.000	0,043134	109.215
Others	68.687.000	0,040312	2.768.910
Without price	50.414.000		
TOTAL	**806.159.000**		**33.545.818**
SYSTEM LOSS AND LEAKAGE	**175.196.000**		
ratio %	**17,85**		

The application of performance based regulation for year 2001 ,with taking consumer price index 0.52 , productivity factor 0,48 and effect of performance base regulation 0,09 yields below results.

Table 6.8. Sakarya Region year 2000 PBR applied

Year 2000 PBR applied			
ENERGY	**QUANTITY(kWh)**	**UNIT PRICE(YTL/kWh)**	**Total Price(YTL)**
SUPPLIED TOTAL ENERGY	**981.356.000**		
TOTAL ENERGY SOLD	**806.159.000**		
Residential	281.924.000	0,0409773	11.552.484
Commercial	132.772.000	0,0487787	6.476.446
Public	29.337.000	0,0487787	1.431.021
Industry	238.298.000	0,0403864	9.623.998
Agriculture	2.195.000	0,0229425	50.359
Lighting	2.532.000	0,0409773	103.755
Others	68.687.000	0,0382964	2.630.465
Without price	50.414.000		
TOTAL	**806.159.000**		**31.868.527**
Productivity Factor(PF)	**Consumer price index(CPI 1999)**	**PBR gain**	
0,48	0,52	0,09	

With applying performance based regulation ,it is predicted that approximately 1,7 million YTL might be have been saved in 2000.

For the year 2001, Sakarya region's electric consumption rates were investigated .For the year 2001 total spent money for electric consumption is 62.096.391YTL and total consumed energy is 0,8 billion kWh.

Table 6.9. Sakarya Region year 2001

Year 2001 without PBR			
ENERGY	**QUANTITY(kWh)**	**UNIT PRICE(YTL/kWh)**	**Total Price(YTL)**
SUPPLIED TOTAL ENERGY	**1.004.534.000**		
TOTAL ENERGY SOLD	**761.700.000**		
Residential	273.211.000	0,083104	22.704.927
Commercial	124.725.000	0,098962	12.343.035
Public	41.836.000	0,098962	4.140.174
Industry	222.176.000	0,081943	18.205.768
Agriculture	2.631.000	0,050004	131.561
Lighting	2.383.000	0,083104	198.037
Others	55.900.000	0,078227	4.372.889
Without price	38.838.000		
TOTAL	**761.700.000**		**62.096.391**
SYSTEM LOSS AND LEAKAGE	**242.834.000**		
ratio %	**24,17**		

The application of performance based regulation for year 2001 ,with taking consumer price index 0.60 , productivity factor 0,48 and effect of performance base regulation 0,13 yields below results.

Table 6.10. Sakarya Region year 2001 PBR applied

Year 2001 PBR applied			
ENERGY	**QUANTITY(kWh)**	**UNIT PRICE(YTL/kWh)**	**Total Price(YTL)**
SUPPLIED TOTAL ENERGY	**1.004.534.000**		
TOTAL ENERGY SOLD	**761.700.000**		
Residential	273.211.000	0,08227296	22.477.878
Commercial	124.725.000	0,09797238	12.219.605
Public	41.836.000	0,09797238	4.098.772
Industry	222.176.000	0,08112357	18.023.710
Agriculture	2.631.000	0,04950396	130.245

Table 6.10. continue…

Lighting	2.383.000	0,08227296	196.056
Others	55.900.000	0,07744473	4.329.160
Without price	38.838.000		
TOTAL	**761.700.000**		**61.475.427**
Productivity Factor(PF)	**Consumer price index(CPI 2000)**	**PBR gain**	
0,48	0,6	0,13	

With applying performance based regulation ,it is predicted that approximately 0,6 million YTL might be have been saved in 2001.

6.3.3. Bolu PBR application for 2000 and 2001

For the year 2000, Bolu region's electric consumption rates were investigated .For the year 2000 total spent money for electric consumption is 20.468.729YTL and total consumed energy is 0,5 billion kWh.

Table 6.11. Bolu Region year 2000

Year 2000 without PBR			
ENERGY	**QUANTITY(kWh)**	**UNIT PRICE(YTL/kWh)**	**Total Price(YTL)**
SUPPLIED TOTAL ENERGY	**530.613.000**		
TOTAL ENERGY SOLD	**484.317.000**		
Residential	104.074.000	0,043134	4.489.128

Table 6.11. continue…

Commercial	39.319.000	0,051346	2.018.873
Public	12.228.000	0,051346	627.859
Industry	282.030.000	0,042512	11.989.659
Agriculture	715.000	0,02415	17.267
Lighting	0	0,043134	0
Others	32.892.000	0,040312	1.325.942
Without price	13.059.000		
TOTAL	**484.317.000**		**20.468.729**
SYSTEM LOSS AND LEAKAGE	**46.297.000**		
ratio %	**8,73**		

The application of performance based regulation for year 2000 ,with taking consumer price index 0.52 , productivity factor 0,46 and effect of performance base regulation 0,08 yields below results.

Table 6.12. Bolu Region year 2000 PBR applied

Year 2000 PBR applied			
ENERGY	**QUANTITY(kWh)**	**UNIT PRICE(YTL/kWh)**	**Total Price(YTL)**
SUPPLIED TOTAL ENERGY	**530.613.000**		
TOTAL ENERGY SOLD	**484.317.000**		
Residential	104.074.000	0,04227132	4.399.345
Commercial	39.319.000	0,05031908	1.978.496
Public	12.228.000	0,05031908	615.302
Industry	282.030.000	0,04166176	11.749.866
Agriculture	715.000	0,023667	16.922
Lighting	0	0,04227132	0
Others	32.892.000	0,03950576	1.299.423
Without price	13.059.000		

Table 6.12. continue…

TOTAL	484.317.000		**20.059.355**
Productivity Factor(PF)	**Consumer price index(CPI 1999)**	**PBR gain**	
0,46	0,52	0,08	

With applying performance based regulation ,it is predicted that approximately 0,4 million YTL might be have been saved in 2000.For the year 2001, Bolu region's electric consumption rates were investigated .For the year 2001 total spent money for electric consumption is 26.198.617YTL and total consumed energy is 0,3 billion kWh.

Table 6.13. Bolu Region year 2001 PBR

Year 2001 without PBR			
ENERGY	**QUANTITY(kWh)**	**UNIT PRICE(YTL/kWh)**	**Total Price(YTL)**
SUPPLIED TOTAL ENERGY	**378.698.000**		
TOTAL ENERGY SOLD	**761.700.000**		
Residential	79.971.000	0,083104	6.645.910
Commercial	36.915.000	0,098962	3.653.182
Public	20.731.000	0,098962	2.051.581
Industry	131.872.000	0,081943	10.805.987
Agriculture	667.000	0,050004	33.353
Lighting	1.394.000	0,083104	115.847
Others	36.979.000	0,078227	2.892.756
Without price	12.842.000		
TOTAL	**321.371.000**		**26.198.617**
SYSTEM LOSS AND LEAKAGE	**57.327.000**		
ratio %	**15,14**		

The application of performance based regulation for year 2001 ,with taking consumer price index 0.60 , productivity factor 0,48 and effect of performance base regulation 0,13 yields below results

Table 6.14. Bolu Region year 2001 PBR applied

Year 2001 PBR applied			
ENERGY	**QUANTITY(kWh)**	**UNIT PRICE(YTL/kWh)**	**Total Price(YTL)**
SUPPLIED TOTAL ENERGY	**378.698.000**		
TOTAL ENERGY SOLD	**321.371.000**		
Residential	79.971.000	0,08227296	6.579.451
Commercial	36.915.000	0,09797238	3.616.650
Public	20.731.000	0,09797238	2.031.065
Industry	131.872.000	0,08112357	10.697.927
Agriculture	667.000	0,04950396	33.019
Lighting	1.394.000	0,08227296	114.689
Others	36.979.000	0,07744473	2.863.829
Without price	12.842.000		
TOTAL	**321.371.000**		**25.936.630**
Productivity Factor(PF)	**Consumer price index(CPI 2000)**	**PBR gain**	
0,48	0,6	0,13	

With applying performance based regulation ,it is predicted that approximately 0,25 million YTL might be have been saved in 2001.

6.3.4. Düzce PBR application for 2000 and 2001

For the year 2000, Düzce region's electric consumption rates were investigated .For the year 2000 total spent money for electric consumption is 13.956.318YTL and total consumed energy is 0,3 billion kWh.

Table 6.15. Düzce Region year 2000

Year 2000 without PBR			
ENERGY	**QUANTITY(kWh)**	**UNIT PRICE(YTL/kWh)**	**Total Price(YTL)**
SUPPLIED TOTAL ENERGY	**402.318.000**		
TOTAL ENERGY SOLD	**326.275.000**		
Residential	118.145.000	0,043134	5.096.066
Commercial	51.829.000	0,051346	2.661.212
Public	22.249.000	0,051346	1.142.397
Industry	111.930.000	0,042512	4.758.368
Agriculture	943.000	0,02415	22.773
Lighting	903.000	0,043134	38.950
Others	5.868.000	0,040312	236.551
Without price	14.408.000		
TOTAL	**326.275.000**		**13.956.318**
SYSTEM LOSS AND LEAKAGE	**76.043.000**		
ratio %	**18,90**		

The application of performance based regulation for year 2000 ,with taking consumer price index 0.52 , productivity factor 0,49 and effect of performance base regulation 0,10 yields below results.

Table 6.16. Düzce Region year 2000 PBR applied

Year 2000 PBR applied			
ENERGY	**QUANTITY(kWh)**	**UNIT PRICE(YTL/kWh)**	**Total Price(YTL)**
SUPPLIED TOTAL ENERGY	**530.613.000**		
TOTAL ENERGY SOLD	**326.275.000**		
Residential	118.145.000	0,04011462	4.739.342
Commercial	51.829.000	0,04775178	2.474.927
Public	22.249.000	0,04775178	1.062.429
Industry	111.930.000	0,03953616	4.425.282
Agriculture	943.000	0,0224595	21.179
Lighting	903.000	0,04011462	36.224
Others	5.868.000	0,03749016	219.992
Without price	14.408.000		
TOTAL	**326.275.000**		**12.979.376**
Productivity Factor(PF)	**Consumer price index(CPI 1999)**	**PBR gain**	
0,49	0,52	0,1	

With applying performance based regulation ,it is predicted that approximately 1,00 million YTL might be have been saved in 2000.

For the year 2001, Düzce region's electric consumption rates were investigated .For the year 2001 total spent money for electric consumption is 23.758.038YTL and total consumed energy is 0,3 billion kWh.

Table 6.17. Düzce Region year 2001

Year 2001 without PBR			
ENERGY	**QUANTITY(kWh)**	**UNIT PRICE(YTL/kWh)**	**Total Price(YTL)**
SUPPLIED TOTAL ENERGY	**330.125.000**		
TOTAL ENERGY SOLD	**761.700.000**		
Residential	109.338.000	0,083104	9.086.425
Commercial	42.795.000	0,098962	4.235.079
Public	7.142.000	0,098962	706.787
Industry	108.146.000	0,081943	8.861.808
Agriculture	432.000	0,050004	21.602
Lighting		0,083104	0
Others	10.819.000	0,078227	846.338
Without price	14.989.000		
TOTAL	**293.661.000**		**23.758.038**
SYSTEM LOSS AND LEAKAGE	**36.464.000**		
ratio %	**11,05**		

The application of performance based regulation for year 2001 ,with taking consumer price index 0.60 , productivity factor 0,48 and effect of performance base regulation 0,14 yields below results.

Table 6.18. Düzce Region year 2001 PBR applied

Year 2001 PBR applied			
ENERGY	**QUANTITY(kWh)**	**UNIT PRICE(YTL/kWh)**	**Total Price(YTL)**
SUPPLIED TOTAL ENERGY	**330.125.000**		
TOTAL ENERGY SOLD	**293.661.000**		
Residential	109.338.000	0,08144192	8.904.697
Commercial	42.795.000	0,09698276	4.150.377
Public	7.142.000	0,09698276	692.651
Industry	108.146.000	0,08030414	8.684.572
Agriculture	432.000	0,04900392	21.170
Lighting	0	0,08144192	0
Others	10.819.000	0,07666246	829.411
Without price	14.989.000		
TOTAL	**293.661.000**		**23.282.877**
Productivity Factor(PF)	**Consumer price index(CPI 2000)**	**PBR gain**	
0,48	0,6	0,14	

With applying performance based regulation ,it is predicted that approximately 0,5 million YTL might be have been saved in 2001.

6.4. Recommandations for PBR application in Turkey

In Turkey, in order to apply performance based regulation effectively these considerations must be taken into account.

- Electric retail utilities must be responsible for the electric service quality.

- The maximum target durations for unplanned outages and their frequency in a year must be determined before the application start.By Energy Market Regulation Commision, this was determined and will be in use on 1 January 2007. For every outage which is longer than the maximum outage duration , utility will give 20 YTL to residential customers and 80 YTL to other customers as penalty.

- With regulations continuity of electricity service ,commercial quality of electricity and technical quality of electicity must be determined.

- Regulatory authority must monitor the performance of the electric distribution company by providing to take necessary measurements and record these obtained data.It must also control or make contol the distribution utility in certain periods of time.

- Regulatory authority must pay enough attention to customer complaints.If necesary ,must give penalty to utility according to the complaints.

- Distribution utility must record the outage dates,duration , frequency and outage reason properly whether the outage is short or not.

- If the outage is long , the outage voltage level ,exact starting - finishing time of the outage ,number of voltage dependent customers efected must be recorded.

- Long outages must be classified as planned and unplanned outages.

- The rocerded data must be submitted to regulatority authority at fixed date annually.

- Distribution utility must submit the quality and performance rates to the public regulary via internet or press.

- Distribution company must share its outages records to the customers if customers demand.

- Distribution utility must inform the customers about outages via internet,press or television.Otherwise it should compensate .

- Rate payments must be informed to consumers before certain period of time .Otherwise customers can pay some ratio of the payment

- Telephones coming to call center of the distribution utility must be answered in certain period of time.

- Distribution utility must install the required equipment in order to measure the technical quality of the electricty (like magnitude, frequency, harmonics and dips).

CHAPTER VII

CONCLUSIONS

Regulation of electric utilities provides number of benefits. For the customers, regulation enables quality service at reasonable prices with respect to cost. For the utilities regulation enables to earn a proper rate of return related to the performance.

Cost of service/rate of return regulation based on the principle of operating the utility has success in electric distribution service. In the future, the electric distribution system will be more competitive and their structures and operating principles will be rapidly changing. The main driving forces for restructuring the regulation system are changes in the technology and the changes in capital markets. A privatized electric distribution utility appears to retain the same monopoly powers as those of the government owned utilities. These changes will put extra stress on the cost of service/rate of return regulation, because these changes will impose pressure on the electric distribution utility to be more efficient, implying that the cost of service/rate of return regulation is too simple and not suitable for realizing this objective. Competitive market conditions requires rapid actions, adapting prices to technological progress and satisfying various customer demands on the price, quality and performance. These are the issues for which cost of service/rate of return regulation is not well suited.

Performance based regulation is proposed as an alternative to cost of service/rate of return regulation. With performance based regulation, the standards of regulation are moved away from utility costs and returns to measures of performance important to the customers, like prices, revenues, or service quality. Although performance based regulation should increase the incentive for an electric distribution utility to be efficient and make it better prepared for competition, it cannot easily be said that utilities with performance based regulation mechanisms are likely to be more competitive than non performance based regulated utilities.

Performance based regulation should have just single and simple mechanism for realizing the cost and quality objectives. Although it may include different components, a single mechanism would clearly show the relationships of all the factors that drive measured performance and profits. Performance based regulation mechanisms combine all the incentives based on financial targets into one incentive mechanism.

For the regulatory authorities, the challenge is to facilitate an effective transition to the new regulatory structures. Although its potential difficulties should be kept in mind, performance based regulation should be considered as the suitable regulation for monopoly services and as a transitional pricing mechanism on competitive services.

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APPENDIX A

PERFORMANCE BASED REGULATION CASE STUDIES

1.1. Southern California Edison

The Commission order for Southern California Edison's, an electricity utility, states that it considers performance based regulation an alternative to the traditional regulatory authority model which links costs directly to rates and does not include an independent and explicit incentive to increase efficiency through lowered costs. To encourage efficiency, performance based regulation breaks the feedback link from costs to rates and includes an incentive for the utility to reduce costs. Performance based regulation must include appropriate service and safety standards. Performance based regulation is seen as emulating the competitive process to encourage utility management to make efficient decisions.

Southern California Edison's performance based regulation mechanism for transmission and distribution is a revenue cap and modified price cap plan. The plan has a 5-year term, which started in January of 1997 and extends to December 2001. When the Federal Energy Regulatory Commission (FERC) and the California Public Utilities Commission adopt a separation of both the rate base and base rate revenue requirement between transmission and distribution, the current performance based regulation plan will continue for distribution only. The plan incorporates an escalation index for inflation, incremental revenues for customer growth, productivity offset, a sharing mechanism, and adjustments for extraordinary items (Z factor).

1.1.1. Inflation Index

The inflation index used in Southern California Edison's performance based regulation plan is the consumer price index. However, because the consumer price index includes prices of inputs used by all industries and not just the electricity industry, the Commission asked Southern California Edison to complete a study that defines an industry specific price index for their midterm review.

1.1.2. Customer Growth Measure

Southern California Edison's performance based regulation plan includes a customer growth measure to ensure that the new customer allowance is added to the revenue requirement. Without this adjustment, the prices would decline in the subsequent years when the unadjusted revenue requirement is divided by the increased sales associated with customer growth.

The customer growth adjustment used is the incremental cost per new customer times the number of new customers expected in the year. The most current historical value for customer growth is used as an estimate for the expected number of new customers.

1.1.3. Productivity Measure

Southern California Edison included a non-generation productivity value of 0.9% based on a 1995 Southern California Edison total productivity factor and added a stretch factor of 0.5% to it to obtain a proposed value of 1.4%.

The Commission convinced that Southern California Edison will discover opportunities for cost reductions as it works with employees over the course of the performance based regulation plan term, adopted a productivity measure of 1.2% for 1997, 1.4% for 1998 and 1.6% for 1999 through 2001.

In its decision the Commission expressed its preference for a productivity factor in the range of 2%. In its mind, the productivity factors for the term of the performance based regulation plan represent a continuation of business rather than a level that would force a fundamental change in culture and strategy to meet the new competitive environment. However, with the opportunity of revisiting the productivity factor at the mid-term review, the Commission supported the revised proposal

1.1.4. Earnings Sharing Mechanism

If Southern California Edison achieves higher productivity than the plan stipulates, a revenue-sharing mechanism will share the cost reductions with the ratepayers. The sharing mechanism is intended to give Southern California Edison an incentive to achieve higher productivity and give ratepayers a substantial share of the cost reductions.

The sharing mechanism is based on net revenue and is built around a benchmark of the authorized return on equity. The plan includes a trigger mechanism that adjusts the return on equity by half the value of the change in the bond index to reflect expected inflation.

The shareholders receive all the gains/losses up to 50 basis points around the benchmark. The rationale is that this assigns the gains/losses associated with routine operation, such as effect of temperature on revenue, to the shareholders. Between 50 and 300 basis points, the shareholders' share rises from 25 through 100 per cent while the ratepayers' share declines from 75 to 0 percent. All gains/losses above 300 basis points are assigned to the ratepayers.

Should the earned return fall in excess of 600 basis points below the benchmark, Southern California Edison has the option of applying for reconsideration of the sharing mechanism and the performance based regulation plan. If the earned return rises in excess of 600 basis point above the benchmark, Southern California Edison is required to apply for reconsideration of the sharing mechanism and performance based regulation plan.

1.1.5. Z Factors

Sets of criteria were established to assess items that might be included as unexpected or extraordinary events (Z factors). The criteria are that the event must be exogenous to the utility; occur after implementation of the performance based regulation plan; have costs that cannot be controlled; have costs that are not a normal part of doing business; affects the utility disproportionately; have costs that are not implicitly included in the performance based regulation plan; have costs that must have a major impact on the utility; and, have costs that must be reasonably incurred by the utility.

The Electric Revenue Adjustment Mechanism (ERAM) allows the utility to recover, in a subsequent year price adjustment, its authorized level of base price revenue requirement when actual and expected sales differ. The divergence may be due to daily variation in temperature, variation in local economic conditions, or long-term effects due to energy conservation. The ERAM allows the utility to recover its authorized level of base rate revenue requirement despite sales fluctuations resulting from these factors.

1.1.6. Service Quality Performance

Southern California Edison's performance based regulation plan includes performance based regulation mechanisms for the following service quality indicators: service reliability, customer satisfaction, and health and safety. The two performance based regulation mechanisms included for service reliability are duration of outages and frequency of outages. The performance standards are based on performance history and a rolling 2-year average is used to accommodate the year-to-year statistical variability. A reward and penalty mechanism is used for both service quality indicators with a dead band around the standard within which there are no rewards or penalties.

For performance in customer satisfaction, Southern California Edison is using an external company to conduct a survey of a sample of customers on aspects such as response time, problem resolution, and customer comparison of Southern California Edison customer service with similar service contacts. The performance history standard is used as the standard with a reward and penalty mechanism included.

The standard for health and safety is the ratio of the total number of accidents and illnesses per 200,000 hours worked or per 100 employees. The standard is based on data from the past seven years. The mechanism has a dead band around the standard and a reward and penalty scheme outside of the dead band.

1.2. San Diego Gas and Electric

As in the case of Southern California Edison, San Diego Gas and Electric is faced with California's introduction of retail open access in January of 1998. San Diego Gas and Electric's performance based regulation plan is a revenue cap with a five-year term, from 1994 through 1998.

San Diego Gas and Electric's objectives are to move to market driven decision making and to reduce the significant burden and inefficiency that arise from traditional regulatory authority oversight. San Diego Gas and Electric recently noted that it was able to lower costs by aggressive refinancing of debt [24]. Its performance based regulation plan is intended to enhance the potential benefits of market forces to its customers, to provide reasonable, effective and continuing oversight by the Commission, and to allocate risks and rewards reasonably among ratepayers and stockholders.

San Diego Gas and Electric has three performance based regulation plans: a gas procurement mechanism, an electric generation and dispatch mechanism, and a base rate mechanism. The base rate mechanism is a performance based regulation plan that sets the revenue cap for operating, maintenance and capital expenses. This is the only one of the three mechanisms described here since it is the mechanism relevant for the purpose of this report.

San Diego Gas and Electric's base rate performance based regulation plan includes an annual revenue requirement mechanism, a revenue sharing mechanism, performance indicators, and a monitoring and evaluation procedure.

1.2.1. Revenue Requirement

San Diego Gas and Electric's plan has separate revenue cap formulas for (1) operating and maintenance expenses, and (2) capital costs.

The performance based regulation formula for the operating and maintenance revenue cap includes labor and non-labor inflationary indices. Further, the formula assumes that productivity offsets customer growth at a rate of 1.5% per year. Thus, if customer growth is greater than 1.5%, the customer growth/productivity adjustment factor is increased. If customer growth is less than 1.5%, the customer growth/productivity adjustment factor is decreased.

Capital related costs are estimated using regression analysis between customer growth and plant additions.

1.2.2. Earnings Sharing Mechanism

The allowed rate of return on rate base will continue to be determined as it was with cost of service / rate of return regulation. The earnings-sharing mechanism compares the rate of return earned in the historical 12-month period to the authorized rate of return. A revenue-sharing mechanism has the utility taking sole responsibility for losses up to 300 basis points below the authorized rate of return, and gains up to 100 basis points above the authorized rate of return. At 100 to 150 basis points above the authorized rate of return the gains are shared between the ratepayers and the shareholders at a ratio of 1:4. At 150 to 300 basis points above the authorized rate of return gains are shared equally between ratepayers and shareholders. At 300 basis points above the authorized rate of return, a review is triggered.

1.2.3. Performance Indicators

Performance based regulation mechanisms are included for the following performance indicators: employee safety, customer satisfaction, service reliability, and electricity rates.

In employee safety, the utility can earn up to $3 million for coming below the benchmark, and can be penalized up to $5 million if the benchmark is exceeded. The criterion used is the lost time accident frequency measure used by OSHA. The benchmark, set at 1.20 units, is based on San Diego Gas and Electric's historic performance. Performance above or below the OSHA standard provides for higher rewards or penalties.

For customer satisfaction the criterion used is the utility's Customer Service Monitoring System (CSMS) results for the previous year with the benchmark set at a 92% survey response level of "very satisfied". Rewards and penalties increase symmetrically around the benchmark up to a maximum reward of $2 million for a survey indicating a 95% or greater response level of "very satisfied", and a maximum penalty of $2 million for a survey indicating a 89% or lower response level of "very satisfied. The service reliability criterion used is the utility's System Average Interruption Duration Index. This index is the average cumulative service interruption duration per customer, exclusive of events such as earthquakes and severe storms. The benchmark is set at 70 minutes. The reward or penalty is $200,000 per minute.

The benchmark for pricing performance based regulation mechanisms are the national average prices for investor-owned utilities. In recent years, San Diego Gas and Electric's rates have been at about 149% to 129% of this benchmark. The benchmark will decline by 1% a year reaching 132% in 1998. The utility will be rewarded $1 million for each 0.5% below the benchmark, and will be penalized $1 million for each 0.5% above the benchmark.

1.2.4 Monitoring and Evaluation

A monitoring and evaluation system is in place to assure that adequate data is available for the Commission to monitor and evaluate the program. The monitoring program includes semiannual reports and a mid-point review for "fine-tuning" of data collection. The evaluation plan requires annual reports with the utility's management evaluation, and an independent review by the Commission. The monitoring and evaluation process will form the basis for the decision to continue, modify or discontinue the performance based regulation plan.

1.3. New South Wales

The Independent Pricing and Regulatory Tribunal (IPART) of New South Wales in Australia regulates the prices of the six electricity distributors serving the region. Separate revenue cap formulas are used to regulate the network and supply charges. Since this paper is concerned with the regulation of network systems, only the revenue cap for the network charges are described.

While a revenue cap is used in the regulation of the network systems, there was no mention of performance measures for reliability and quality of service in the description of the plan.

The transmission system's (Trans Grid) rate order covers the period 1996-1999. For March 1996 through June 1997 the monopoly transmission services revenue was capped at $355 million.

For July, 1997 to June 1999 Tran grid's revenue will be adjusted and capped using the following formula:

Maximum Revenue = [Fixed Charge * (consumer price index - X)] +

[(Energy Charge * Projected Peak and Shoulder kWh) * (consumer price index-X)]

[(Demand Charge * Projected demand Mwh) * (consumer price index -X)]

The consumer price index used is the increase in the average of the all-groups for the city of Sydney for the four quarters to March relative to the index for the same period in the previous year.

The distributors' rate order is in effect from June 1997 to June 1999. The revenue cap formula is as follows:

$DOUSC = [\{a+(b1N1 + b2N2 + b3N3) + cM+dL+K\}*\{1+(\text{consumer price index}-X\}] + QT$

DOUSC = Distribution Use of System Charges = Total Network Revenue

N1,2,3 = Customer number by customer size

K = Loss adjustment factor

M = MWh sales

L = Circuit Kilometres (applies to rural distributors only)

a = Residual constant capturing other costs,

b = dollar margin per customer for each customer size

c = Dollar margin per MWh

d = Dollars per circuit kilometres

consumer price index = increase in average of the all-groups consumer price index for Sydney for the four quarters to March relative to the index for the same period in the previous year

QT = Payments by NorthPower for Queensland transmission costs for supply to customers in Tweed (customers in Tweed are currently supplied by Queensland).

1.3.1 Productivity Factor

The X factor for the distributors ranges from 0.0% to 3.5%.

1.3.2. Pricing

In addition to the revenue cap formula the distributors have side constraints on their network prices including the limitations described below.

1.3.3. Residential Tariffs

Any increase in the bill of any individual residential customer may not exceed the greater of:

- Consumer price index; or
- For customers on non- off-peak tariffs, $5.00 per quarter; or
- For customers on off-peak tariffs, $7.00 per quarter.

Any increase in the average residential tariff for the total residential group may not exceed 80 percent of the applicable consumer price index.

1.3.4. Rural Rates

Any increase in the domestic component of a rural tariff is also subject to the same preceding constraints applicable to the bill of a residential customer.

1.3.5. Commercial or Industrial Customers

The bill for any commercial or industrial customer may not increase by more than the greater of:

- 5 percent in real terms, or
- $50 per annum.

1.4. Southern California Gas

In December of 1995, the California Public Utilities Commission issued its restructuring order establishing retail open access starting January 1, 1998.

The Southern California Gas base rate performance based regulation, that came into effect on January 1, 1998, includes a revenue indexing formula, revenue-sharing, a cost of capital trigger mechanism, a Z-factor and exclusions, service quality, customer satisfaction and safety incentives; and, a monitoring and evaluation program.

The revenue indexing formula incorporates inflation, productivity and customer growth and is as follows:

Year 2 Revenue Requirement/customer = Year 1 Revenue Requirement/customer (1+inflation-X)

1.4.1. Inflation Index

The inflation index is the weighted average of labor operating and maintaining, non-labor operating and maintaining, and capital related cost inflation factors for gas operations for Southern California Gas, Pacific Gas and Electric and San Diego Gas and Electric.

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1.4.2. Productivity Factor

The productivity factor has two components: (1) a historic measure of industry productivity and (2) an additional ramped productivity target based on potential incremental productivity improvement the utility can expect to achieve over and above the first component. In addition, the Commission included a 1% increase to the second component to account for potential rate base reductions under Southern California Gas' control. The total productivity factor is 2.1% for year 1, 2.2% for year 2, 2.3% for year 3, 2.4% in year 4, and 2.5% in year 5.

1.4.3. Sharing Mechanism

Southern California Gas's performance based regulation plan has a 25 basis point dead band above its authorized rate of return to allow for minor fluctuations in operations. Between 25 and 300 basis points above the benchmark, there are eight bands with differing revenue sharing proportions as follows:

25 Basis Points:	25% shareholder	75% ratepayers
50 Basis Points:	35% shareholder	65% ratepayers
75 Basis Points:	45% shareholder	55% ratepayers
100 Basis Points:	55% shareholder	45% ratepayers
125 Basis Points:	65% shareholder	35% ratepayers
150 Basis Points:	75% shareholder	25% ratepayers
200 Basis Points:	85% shareholder	15% ratepayers
250 Basis Points:	95% shareholder	5% ratepayers
300 Basis Points:	100 % shareholder	0% ratepayers

1.4.4. Z Factors and Exclusions

The Z factor allows for costs associated with events beyond the scope of the performance based regulation plan to be passed through. Southern California Gas notifies the Commission when such an event occurs and provides a detailed account of the event. The notification is followed by a supplement to the annual rate adjustment procedure for review by the Commission.

Some costs that are beyond the control of Southern California Gas , or that are handled by existing regulatory authority mechanisms, are excluded from the Z factor. These costs are subject to adjudication by the Commission and include:

- Catastrophic Event Memorandum Account (CEMA)
- Hazardous Substance Cost Recovery Account (HSCRA)
- Low Emission Vehicle (LEV) Program
- Regulatory Transition Costs
- Wheeler Ridge Interconnection Costs and Revenues
- Mandated Social Programs
- Gas costs and Pipeline Demand Charge
- Costs Imposed by the Commission

1.4.5 Capital Trigger Mechanism

Southern California Gas's performance based regulation plan includes a "trigger" in the event of a dramatic change in cost of capital as per the 12-month trailing average yield on long-term Treasury Bonds. If increases exceeds 150 basis points over the rate of return benchmark and is forecasted to continue to do so, rates would automatically be adjusted according to a pre-established formula.

1.4.6. Performance Indicators

Southern California Gas' performance indicators include customer satisfaction, service quality and employee safety. Individual targets are set for the three performance areas and performance below the targets result in potential rate reductions.

Customer satisfaction includes:

1. Customer satisfaction with the telephone customer service representative;

2. Customer satisfaction with the scheduling of an appointment for a field call;

3. Satisfaction with the field Appliance Service Representative; and,

4. Percentage of on-time arrival for the service call.

Each of the four targets has a one-point dead band below the target. Below the dead band, the utility is penalized $10,000 per 0.1 point decline for the first point below the dead band, and $20,000 per 0.1 point thereafter.

In addition, the call center performance standard requires 80% of the telephone calls to be answered within 60 seconds for regular calls, and 90% of all leak and emergency calls to answer within 20 seconds.

Southern California Gas is responsible for providing quarterly reports to the Commission with monthly data on some of the performance indicators. Total penalties of more than $4 million will trigger a Commission investigation.

Employee safety measures the number of incidents per 20,000 hours worked. The annual benchmark is the California Occupational Safety and Health Administration's (OSHA) Record able Injury and Illness rate currently at 9.3 incidents with a dead band around the benchmark of 1.0. Penalties or rewards are imposed above and below the dead band, respectively at $20,000 per 0.1 point.

1.4.7. Monitoring and Evaluation

Southern California Gas is required to file an annual performance based regulation performance report that reviews the performance based regulation performance, earnings sharing, service quality, customer satisfaction, and safety incentives.

APPENDIX B

DETERMINATION OF THE PRODUCTIVITY FACTOR

We examine the appropriate choice of an X factor in RPI-X (or price cap) regulation. After providing a basic guideline, we explain how to modify this guideline to account for: (1) limited spans of regulatory control; (2) anticipated structural changes in the regulated industry, such as a strengthening of competitive forces; (3) major impacts of the pricing decisions of the regulated firm on the economy-wide rate of price inflation; and (4) imperfect competition outside of the regulated sector.

1. Introduction

Price cap regulation — sometimes known as RPI-X regulation — has become a popular form of regulation in many industries, including the telecommunications industry, In the United States, for example, most state governments now employ some form of price cap regulation to govern the intrastate activities of their telecommunications suppliers. Price cap regulation typically specifies an average rate at which the prices that a regulated firm charges for its services must decline, after adjusting 'for inflation. This rate is called the X factor.

The proper choice of an X factor is critical for the long-term viability of any price cap regulation plan. If too small an X factor is imposed, the regulated firm will earn excessive profit and thereby jeopardize political support for the regulatory regime. If too large an X factor is imposed, the financial integrity of the regulated firm can be threatened. The essence of price cap regulation, therefore, is to select an X factor that poses a significant, but not insurmountable, challenge to the regulated firm, and that promises gains for consumers relative to alternative regulatory regimes. The purpose of this article is to explain how to select an appropriate value for the *X* factor when implementing price cap regulation. In Section 2, we provide a basic guideline: the X factor should reflect the extent to which the regulated industry has historically achieved higher productivity growth and faced lower input price inflation than other industries in the economy. This guideline is appropriate during the specified period of price cap regulation when the following four conditions hold:

- all of the regulated firm's services are subject-to-price cap regulation;
- no major structural changes (such as a strengthening of competitive forces) are anticipated in the regulated industry;
- the rate of price inflation outside of the regulated sector is not affected by the pricing decisions of the regulated firm
- the economy outside of the regulated sector is competitive.

2. The Basic Guideline

Price cap regulation is intended to replicate the discipline of competitive market forces. Competitive forces compel firms to realize productivity gains and to pass these gains on to their customers in the form of lower prices, after accounting for unavoidable increases in input prices. Therefore, if all industries in an economy were competitive, output prices in the economy would grow at a rate equal to the difference between the growth rate of input prices and the rate of productivity growth.

If the regulated industry were just like the typical sector in a competitive economy, the discipline of competitive forces could be replicated by limiting the rate of growth of regulated prices to the economy-wide of price inflation. This restriction would require the regulated industry to realize the productivity gain's that are realized in other sectors of the economy, arid to pass these gains oh to customers, after adjusting for the typical rate of unavoidable input price inflation. Therefore, the X factor should be zero when the regulated industry is capable of achieving exactly the same productivity growth rate and faces exactly the same rate of input price inflation as other sectors of the competitive economy.

More generally, the X factor should reflect the extent to which: (1) the regulated,- industry is capable of increasing its productivity more rapidly than are other sectors of the economy; and (2) the prices of inputs employed in the regulated industry grow less rapidly than do the input prices faced by other sectors of the economy. If the regulated industry is able to achieve more rapid productivity growth (perhaps due to more rapid technological change, for example) or to realize lower input price inflation than other sectors of the economy, then the regulated industry should be required to pass the associated benefits on to customers in the form of lower prices. To illustrate this basic guideline; consider the following example.

Example 1. The expected annual rate of productivity growth in the regulated industry is 2%, and the corresponding growth rate elsewhere in the competitive economy is 1%. Input prices in the regulated industry are expected to increase 0.5% annually, and the corresponding growth rate of input prices elsewhere in the economy is 1.5%. In this setting, the X factor should be 2% (-[2-1]+ [1.5-0.5]%).

When no major structural changes are anticipated in the economy, historic data on productivity and input-price growth rates often provide reasonable estimate's of corresponding future growth rates. For expositional simplicity, we focus on this case in most of the ensuing discussion. However, if statistics that aid in\the prediction of future growth rates are available, they can also be employed.

3. Extensions of the Basic Guideline

The derivation of the basic guideline assumed: (1) all of the regulated firm's services are subject to price cap regulation; (2) there are no major structural changes in the regulated industry; (3) the rate of price inflation outside of the regulated sector is not affected by the prices set in the regulated industry; and (4) the economy outside of the regulated sector is competitive. In this section, we explain how the basic guideline for setting the X factor should be modified when these conditions are not satisfied.

3.1. Limited Spin of Regulatory Control

In practice, price cap regulation is often applied to only a subset of the services supplied by the regulated firm. For example, in the telecommunications industry, basic local services are typically regulated while enhanced and special services are often unregulated, The basic guideline provided above could be implemented without modification if productivity and input data that pertained exclusively to the firm's regulated operations were available; this is seldom if ever, the case. Available data invariably pertain to the firm's entire operations. Furthermore, joint products and common factors of production generally make it impossible to employ the aggregate data to derive productivity growth rates and input price growth rates separately for "capped services" (those subject to price cap regulation) and for "uncapped services" (those not subject to price cap regulation). Consequently, the guideline described above must be modified to define an appropriate X factor for the firm's capped services, using only measures of productivity and input price growth rates for the firm's entire, operations;

The key modification of the basic guideline is' the following. The X factor should be decreased when the prices of uncapped services are: growing more slowly than the, difference between the growth rate of input prices and the productivity growth rate in the regulated industry. The magnitude of the appropriate decrease is proportional to the fraction of the regulated firm's total revenue that is derived from the sale of uncapped services. The rationale that underlies this adjustment is relatively simple. Price cap regulation is designed to compel the firm to pass on anticipated productivity gains to customers in the form of lower prices, after correcting for unavoidable increases in input prices. If the prices of uncapped services ate rising more slowly than they would be if they reflected only anticipated productivity gains and unavoidable cost increases, then the firm is passing on to elastomers of uncapped services more benefits than price cap regulation of the firm's entire operations would dictate. Therefore, it can be appropriate to permit a compensating reduction in the benefits that must be delivered to the customers of capped services. This reduction can be implemented by reducing the X factor.

The magnitude of the appropriate adjustment to the-X factor can be substantial. To illustrate this fact, consider the following example.

Example 2. The productivity and input price growth rates for the regulated industry and the rest of the economy are as stated in Example 1. One half of the regulated firm's revenue is derived from the sale of uncapped services, and competitive forces preclude price increases on these services. In this setting, the factor should be 0.5% (= 2 - [0 - (0.5 - 2)]%).

The 0.5% *X* factor cited in Example 2 represents the difference between the 2% *X* factor prescribed in Example 1 and the correction for the limited span of regulatory control. This correction (1.5%) is the difference between: (1) the rate of growth of the prices of uncapped services (0%); and (2) the difference between the rate of growth of the regulated[1] firm's input prices (0.5%) and its productivity growth rate (2%).

3.2. Structural Change in the Regulated Industry

Price cap regulation attempts to divorce authorized prices from realized costs. Consequently, it can provide strong incentives for the regulated firm to reduce its operating costs. In contrast, rate-of-return regulation can provide limited incentives for cost reduction to the extent that it reimburses the Regulated firm for realized operating costs. Consequently, when price cap regulation replaces rate of-return regulation ill an industry, firms in the industry can often be expected to achieve a higher productivity growth rate in the future than they have in the past. Therefore, it can be appropriate to augment any historically based estimate of the X factor is called a customer productivity dividend (CPD). In principle, the CPD should reflect the best estimate of the increase in the productivity growth rate in the regulated sector that will be induced by the enhanced incentives in the regulated industry.

Strengthening competitive forces constitute another structural change that can affect the most appropriate value for the X factor under price cap regulation. Perhaps surprisingly, the effect of increased competition on the proper X factor is ambiguous, especially in the short run. On the one hand, increased competition, like a change in regulatory regime, can compel the regulated firm to operate more efficiently and thereby realize a higher productivity growth rate. This effect of increased competition argues for a higher X factor; since it is reasonable to require the regulated firm to pass on to its customers some of the benefits of an anticipated higher productivity growth rate. On the other hand, increased competitive forces can shift industry sales from incumbent suppliers to new entrants. The result can be an unavoidable reduction in the growth rate of the incumbent 'supplier's outputs. Often, and particularly in the short run, this reduction in the growth rate of its outputs can exceed any associated reduction in the growth rate of its inputs, leading to a lower productivity growth rate for the incumbent regulated firm. This effect argues for a lower Z factor. Overall, the direction and magnitude of the most appropriate modification of the X factor to account for strengthening competitive forces reflects the best estimate of the net impact of these countervailing effects.

3.3. Wide Inflation Rate

The logic that underlies the simple guideline presumes that the economy-wide rate of price inflation is not affected directly by the prices in the regulated industry. This assumption can be unrealistic in some settings, particularly, in small developing economies where regulated outputs constitute a large fraction of total production in the economy. In such settings, the simple guideline described above must be modified to account for the endogeneity of the economy-wide rate of price inflation.

The central modification is to weaken the link between the realized rate of price inflation in the economy and the authorized rate of price increase in the regulated industry. In particular, a 1 % increase in the economy-wide rate of price inflation should not authorize a full one percent increase in the rate of price inflation in the regulated industry. The difference between the two inflation rates should generally be greater the larger is the regulated sector relative to the economy as a whole and the greater is the fraction of regulated, revenues derived from the sale of intermediate goods (i.e., those used to make other goods).

To understand the essence of this modification of the basic guideline, suppose the authorized rate of price inflation in the regulated sector increases with the realized rate of price inflation in the economy on a one-for-one basis. Also suppose that higher rates of price inflation in the regulated sector cause higher rates of inflation in the economy as a whole. Under these conditions, price increases in the regulated sector effectively serve to authorize further price increases in the sector. Consequently, the presumed form of price cap regulation will not constrain price increases in the regulated sector appropriately. Effective constraints can be restored by reducing the extent to which the price cap formula authorizes higher growth rates for regulated prices as the realized rate of price inflation elsewhere in the economy increases.

3.4. Imperfect Competition in the Economy

The simple guideline described in Section 2 may also require modification when some of the industries outside of the regulated sector are not competitive. This is the case even if output price inflation in these industries is not affected by the prices set in the regulated industry. In industries that are not competitive,, all productivity gains net of unavoidable cost increases are not necessarily passed on to customers in the form of lower prices. Consequently, the realized rate of price inflation outside of the regulated sector can exceed the rate of price inflation that would arise if all markets were competitive. When this is the case, a higher X factor can be appropriate to offset the extent to which the realized economy-wide inflation rate exceeds the rate that would arise in a competitive environment