Roskilde University

Access pricing in Danish telecommunications and electricity

Olsen, Ole Jess; Falch, Morten

Publication date:
2008

Document Version
Publisher's PDF, also known as Version of record

Citation for published version (APA):
Olsen, O. J., & Falch, M. (2008). *Access pricing in Danish telecommunications and electricity*. Paper presented at 7th Conference on Applied Infrastructure Research, Berlin, Germany.

Access pricing in Danish telecommunications and electricity

Ole Jess Olsen
ENSPAC, Roskilde University
DK-4000 Roskilde
ojo@ruc.dk

Morten Falch
CMI, Aalborg University
DK-2750 Ballerup
falch@cmi.aau.dk

Abstract

Telecommunications and the electricity supply industry were the first infrastructure sectors to be liberalized. After liberalization the former cost-plus regulation was substituted by new principles of incentive regulation of access to the network infrastructure. The two industries have developed quite differently with respect to market structure and regulation.

The objective of this paper is to compare the regulation of access to the network infrastructure in the Danish telecommunications and electricity supply industry, the choice of pricing models and their implementation. In telecommunications the preferred pricing model is Long Run Average Incremental Costs (LRAIC), whereas a mixture of Benchmarking and Revenue Cap Regulation has been introduced for electricity.

The principles of the different access pricing models are briefly discussed. We proceed with a presentation of the concrete pricing models that have been applied in Denmark and discuss their implementation and outcome. The results so far have been positive in telecommunications. In the electricity supply industry they have been disappointing thus demonstrating some of the difficulties of implementing incentive regulation. We conclude with a comparative discussion of the two industries and whether they can learn something from each other.

Keywords: Electricity distribution, Telecommunications, Access pricing

JEL-code: L 94 and L 96

Introduction

Telecommunications and electricity were the first infrastructure sectors to be liberalized. Since liberalization they have developed very different models for market structure and regulation. In telecommunications the incumbent utility continued as a vertically integrated enterprise with regulated access to its infrastructure. In electricity network activities were separated from service activities and conditions of access to the unbundled network became regulated. The former cost-plus regulation has now been substituted in both industries by new principles of regulation, however applying different models. Their different approaches to market structure and regulation can to some extent be explained by different technical conditions that made vertical separation problematic in telecommunications, whereas it has been much more straightforward to implement for electricity.

The objective of this paper is to compare the pricing of access to the network infrastructure in the Danish telecommunications and electricity supply industry, the choice of pricing models and their implementation. In telecommunications the preferred pricing model is Long Run Average Incremental Costs (LRAIC), whereas a mixture of Benchmarking and Revenue Cap Regulation has been introduced for electricity.

The access pricing models that are now applied in Danish infrastructure regulation have a background in the theoretical principles of incentive regulation that were developed to substitute traditional cost-plus regulation. We begin with a short introduction of these principles. Which are their efficiency advantages when compared to traditional cost-plus regulation? We proceed with a presentation of the design of the Danish access pricing models for telecommunications and electricity. Which are their main features and their rationale? Finally, we analyse the implementation of the access pricing models and their outcome. Which is the explanation for the results that so far have been mixed and that have not always fulfilled the original expectations? Finally, we discuss whether the two industries can learn from each other .

Principles of access pricing

Different principles of access pricing have been developed and applied in liberalized infrastructure industries. They are all variants of incentive regulation that was developed as an alternative to traditional cost-plus regulation. The traditional price models ignored the incentives and the private information of the regulated firm, which prevented an efficient outcome. In incentive regulation the regulator takes these problems into account when designing the pricing rules to be applied. Besides providing the right incentives to the regulated firms regulation should also be parsimonious with respect to the work and information requirements of the regulator (see Armstrong et al. 1995).

After liberalization price regulation has become much more limited and will now only include those parts of the industry that are still considered a natural monopoly (distribution and transmission in electricity) or where the incumbent operator is considered temporarily dominant (the fixed network services in telecommunications).

The new industry structure that has developed after liberalization can be expected to have some impact on the choice of regulation. In the electricity supply industry *vertical separation* of generation and sales (competition activities) from network operations (a natural monopoly) has been implemented in Europe and elsewhere. Prices for access to the transmission and distribution networks are now regulated. In most countries a number of network operators exist each with a local or regional monopoly. In telecommunications the former national telecoms have continued as the dominant national operator and have not been forced to vertical separation of their network and services. Instead *access to the network infrastructure* for competing operators has been regulated. Because of that regulation has become a direct game between the incumbent operator and its competitors.

The models now applied in telecommunications and the electricity supply industry are mainly one of the following:

1. Long Range Average Incremental Costs (LRAIC)
2. Benchmarking
3. Price and Revenue Caps

LRAIC was introduced in telecommunications, but cases of similar models exist in the electricity supply industry (see below). Benchmarking models are mainly but not exclusively applied in electricity regulation, whereas price or revenue caps have been common in the regulation of both industries.

LRAIC

LRAIC applies a constructed network that is considered efficient with the existing technology as a benchmark for the costs of providing access to competing operators. The LRAIC concept is developed for use within the EU (see European Commission 1998 and European Parliament 1997), but similar concepts are used elsewhere, for instance TELRIC (Total Element Long Run Incremental Costs) in the US.

In addition to the incentive problem, a cost model for telecom access has to address two other problems that are not so relevant for electricity:

1. How to deal with rapidly decreasing infrastructure investment costs due to technological innovations.
2. How to share costs between different services using the same infrastructure facilities.

LRAIC is defined as the forward-looking long run average costs of adding one increment to the network. The long run implies that all costs of all types of input can be included, also the costs of capital equipment. LRAIC includes all types of costs related to a certain increment and not only the costs of adding one additional increment. Hence the concept of LRAIC is broader than LRIC, which is defined as the marginal costs of adding or removing a certain increment of traffic. Moreover the Danish definition of LRAIC operates with very large increments such as ‘all services in the access network’ or ‘all services in the core network'. All fixed costs related to either the core- or the access networks such as land, buildings or trenches are thus included in the costs of one of these two increments. Only costs shared by the access – and core networks are excluded (National Telecom Agency, 2002)

The idea of using the LRAIC approach is to base access charges on what the cost of an interconnect product would be, if provided at cost based prices by the most efficient network operator. This enables a new entrant to use existing network facilities without paying for possible inefficiencies of the incumbent operator in management, sub-optimal investments etc. This approach addresses the incentive problem mentioned above, as the infrastructure provider pays all costs caused by inefficient operations. One important exception to this is that efficiencies due to the existing location of wire-centers are taken into account (the scorched network approach). By this it is acknowledged that optimization is based on reuse of existing facilities, and that a complete redesign of the network cannot be justified by costs.

Benchmarking

When a number of separate entities exist – companies, departments, outlets, etc. - doing the same thing it's obvious to compare their performance and apply it as a regulatory tool. In a seminal paper from 1985 Shleifer under the name *Yardstick Competition* demonstrated theoretically that this property can be utilized to develop a regulatory model that under certain assumptions provide the regulated entities with the right incentives to achieve a first-best outcome (second-best if money transfers are not possible). The idea is for each company to use the information set from all the others to determine the regulated variable (price, transfer of money).

In industries like electricity supply the distribution companies deliver a uniform good under similar conditions and, therefore, are a relevant case for this model. In most practical examples various econometric techniques are applied such as the Data Envelopment Analysis (DEA) that empirically determines a cost frontier representing the best performing companies, which serves as a benchmark for all companies in the industry. The benchmarking should be combined with a reward system to provide the regulated network operators with the right incentives to improve their cost performance (see Agrell et el. 2005). A main problem with the approach is the need to include the variation in environmental conditions that cannot be influenced by management (e.g. climatic zone or consumer density in the supply of electricity).

As there is usually only one dominating (incumbent) national operator in telecommunications this kind of benchmarking is not really applicable for that industry. Instead some kind of best practice comparisons have been applied (see below)[1].

Price and Revenue Caps

LRAIC and benchmarking are quite demanding with respect to data collection. Price and revenue caps that provide the regulated companies with incentives to reduce their costs over time have the additional virtue to be parsimonious with respect to the collection of cost data. The model was developed during the 80'ies to regulate the privatized and deregulated British infrastructure industries (see Armstrong et al. 1995, Chapter 6). The regulated firm is for a specified period (typically 3-5 years) allowed to change a basket of its prices within a cap that is determined by two factors that are supposed not to be influenced by the firm: the retail price index (RPI) expressing general price changes and a factor (X) expressing the expected technological improvements in the industry (therefore, the model is often called RPI-X). It represents an empirical application of the Finsiger-Vogelsang model (see Vogelsang 1988) that demonstrates theoretical second-best properties (Ramsey-pricing) for a regulated industry when the profits from the previous period are utilized to fix the cap.

The rationale of the model is both to provide the regulated firm with incentives to improve its performance and to share the fruits of this improvement with the consumers during the following periods. The incentive is supposed to be quite strong (a high powered regulation scheme, see Joskow 2006) as the firm will keep any extra profit from improving the performance above that expected from the exogenous determined X.

[1] Comparisons with national telecoms in other countries have been attempted but here the problems of comparing similar companies working under similar conditions are larger than with comparisons within a national context.

However, as the firm can fear to be penalized in subsequent periods for its extra productivity improvements it can choose to respond strategically and thus decrease the gains from the regulation. In practice the X is settled somehow arbitrary and often after negotiations with the regulated firm/industry.

In some industries, where there are natural units of output (e.g. kilowatt hours in electricity), revenues are capped instead of prices. That introduces an additional layer, as the revenue cap is an average for the expected demand a figure for which relevant estimates must be included. That can provide the regulated firm with an incentive to behave strategically with respect to the demand forecast.

The Danish models of access pricing

Telecommunications

LRAIC is agreed to be the most adequate principle for determination of access prices in the Danish telecom sector. However, construction of LRAIC models is both time consuming and costly. For this reason, the Danish telecom legislation includes four different models to be used for price setting:

a. Historic costs
b. Best practice
c. Retail minus
d. LRAIC

From 1996 to 2002 determination of interconnection charges was based on historical costs. The principle was to allow inclusion of the total extra costs related to provision of the service plus a reasonable margin. Five different elements were included in the costs: (1) Direct extra operating costs, (2) A proportion of the costs of new investments needed due to delivery of the interconnect service, (3) A proportion of depreciation and payment of interest for network facilities used for the service, (4) A proportion of the operating cost for these facilities and (5) An overhead of 12% of the total costs of (1)-(4).

The proportions of the costs in (2)-(4) were calculated on basis of the proportion of the traffic delivered through interconnection. However, if the dominant operator (i.e. TDC, the incumbent carrier) had a market share of more than 80%, only 30% of the proportion of the operating costs should be included. This implied that the incumbent operator should bear a part of the interconnection costs until the new entrants had obtained a reasonable market share. In this way the monopolist was required to subsidize its competitors until some of them have established themselves on the Danish market.

The historical cost approach was in 1998 supplemented by a best practice clause, enabling the national telecom regulator to reduce interconnection charges to the international level for best practice, even if TDC was able to document that the actual costs were higher. The definition of best practice has been changed after several debates between the telecom agency, TDC and the new entrants. Best practice was defined as the average of the interconnection rates in the three countries with the lowest interconnection rates. It was also possible for the regulator to reduce rates if they were lower in just one country, but in this case corrections for country specific conditions should be made beforehand. Although both the historical costs approach and the best practice clause are included in the legislation as ways for setting interconnection rates, it is the best practice clause that has been used to reduce the interconnection charges five times since July 1996. This clause has ensured that Danish interconnection charges are always among the lowest in Europe.

The process adopted for introduction of LRAIC in Denmark resembles the approach followed in other EU countries like the UK and Austria (Freund & Ruhle, 2002). In 2002 the work with an LRAIC model including the major interconnection products providing access to the fixed network was completed, and since 2003 major interconnection charges has been set by use of an LRAIC-model. Both the incumbent and new entrant operators contributed to the price setting. LRAIC models should be developed through a co-operation between three parties: The National Telecom Agency (NTA), operators with a strong market position obliged to deliver interconnect services at cost based prices (i.e., TDC), and operators who need to buy these services to complement their own network facilities (the new entrants).

Following intensive discussions among the interested parties, the general modeling principles were set according to three model reference papers completed in late 2000. Thereafter TDC was responsible for preparing a Top-down model based on the existing network, while the Bottom-up Working Group was responsible for the preparation of a bottom-up model of a network building on the current physical network structure, but optimized with respect to technology and configuration (the scorched network approach). This work was completed in late 2001, and the two models have been compared, so a hybrid model based on results from the top-down and bottom-up models could be made.

The exact figures derived from the two cost models were kept confidential, but the reconciliation report drafted by the Danish Telecom Authority indicated that the top-down model ended up with networking costs that were about twice the costs that could be derived from the bottom-up model. The two models were very different with respect to their network architecture, but the main differences originated from different assumptions of:

a. Annualisation rates – mainly due to different assumptions of price trends and costs of capital.
b. Indirect costs, operating costs and overheads.
c. Trench lengths and trench sharing with other utilities.
d. Routing tables and network dimensioning including dimensioning of exchanges.
e. Utilization rates

Based on this work the Danish Telecom Authority constructed a hybrid LRAIC model, in which traffic data is revised every year, while technology assumptions are changed less frequently. From 2009 LRAIC is also used for determination of termination charges in mobile networks.

Electricity

After liberalization in 2000 a new model of incentive regulation of Danish network operators was introduced to substitute the former cost-plus regulation (Energitilsynet 2007). Benchmarking was applied to construct a revenue cap for each operator. The revenue cap combined a general part reflecting the expected performance improvements for the industry with an individual cap reflecting the relative inefficiency of the company derived from the benchmarking (mainly inspired by the Norwegian model developed some years before).

The model was poorly implemented, which is reflected in the fact that many operators took considerably lower prices than those allowed by their individual cap (about 15% lower according to Sørensen 2005, p 15). As a consequence the model was abolished in 2004 and it was decided to develop a better model to be implemented in 2008. In the meantime the network operators were not allowed to raise their prices in real terms. 67 distribution system operators (DSOs) of very different sizes (from about 500,000 customers to less than 1000 customers) and 13 regional transmission system operators (TSOs) are now regulated by the new model[2].

Both the former and the present model are rather simple, which is in contrast to e.g. the Norwegian model that continues to apply a combination of the DEA- and the Price Cap approach (see NVE 1997 and 2007), and the Swedish model that applies a reference firm (engineering-designed) model with certain similarities to the LRAIC-model (see Energimyndigheten 2004 and Jamasb and Pollitt 2008). The Danish Energy Market Authority argues that a simple model makes the results much easier to comprehend for the regulated network operators and thereby increases the pedagogical value of the system: inefficient operators can better understand why they are inefficient.

The *Net Volume* Model calculates the costs incurred by an average operator operating a network similar to that of the operator under investigation. The benchmark in the Danish model is constructed from cost data supplied by all operators in the relevant network group (TSOs, DSOs or transformer co-operatives). For each type of network component j (cable, transformer) is calculated an average "cost equivalent" w_j utilizing data from all operators in the group[3]:

[2] 33 transformer co-operatives are benchmarked separately. Most of them have less than 1000 meters connected.
[3] The model applied for DSOs and transformer co-operatives is slightly different from that applied for TSOs.

$w_j = \sum cost_{ij} / \sum n_{ij}$ where n_{ij} is the number of component j in the network of operator i

A relative cost index is then calculated for each operator by dividing its total costs by the sum of the different net components multiplied by their "cost equivalents" (called its *Net Volume*, which is the total cost of an operator with the same network, but with average costs of each of its component)[4]:

$e_i = \sum cost_j / \sum w_j\, n_j$

As some costs are considered to be outside the influence of management in the short term they are excluded from the costs included in the index. These are the cost of net losses and some costs that are specific for each company such as pension obligations and mergers (which is different from the UK where merger gains should be transferred to the consumers immediately, see Jamasb and Pollitt 2007). In addition some framework conditions will influence the costs incurred by the network operators but are expected to do it in a more systematic way – costs are higher in densely populated than in sparsely populated areas or vary with the climate zone of the operator (not relevant for Denmark). The Energy Market Authority has estimated the statistical relationship between costs and customer density and uses the parameters from the regression as a proxy.

The efficient distribution system operators are identified as those having the lowest relative cost index (corrected for framework conditions) and that together account for 25% of the total Net Volume of all operators in the relevant group (TSOs, DSOs or transformer co-operatives). The relative efficiency of an operator i is then calculated as the ratio between the relative cost index of these operators and its own index:

$E_i = e_{low} / e_i$

[4] The cost equivalents are calculated from a sample from each category representing those operators considered to provide reliable accounting information.

The operators in each group are divided into 5 categories to determine the required performance improvements: those in the highest category should not reduce their costs; those in the next best category should reduce their costs by 1% annually, and the following categories by 2, 3 and 4% respectively. The distribution of network operators in the 5 categories is constructed to ensure that an operator representing the mean relative efficiency in a category will move to the next higher category after five years.

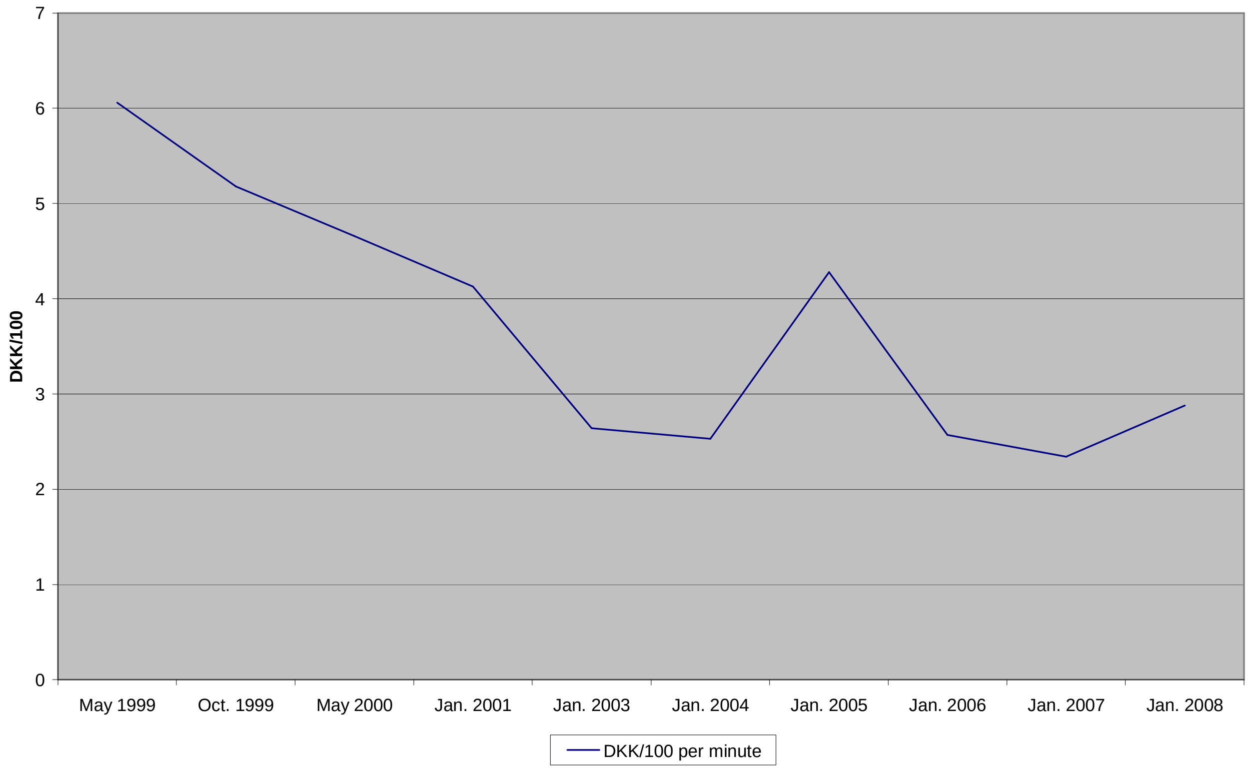
The obligation to improve performance will not cover all costs. Those considered inflexible in the short run such as depreciations and net losses as well as costs that are accepted as extraordinary for the individual operator are excluded (accounting for about 40% of the total costs of an average operator). A revenue cap is decided each year to be active in the following year, i.e. the cap for 2008 is calculated in 2007 on data from the 2006 accounts. As the relevant figures for delivered electricity is not known at that time the required percentage reduction for inefficient network operators is transformed into an absolute amount of money. The required reduction for Danish network operators in 2008 accounts for less than 1% of their total costs.

Implementation and outcome:

Telecommunications

The first agreement on interconnection charges were made between Tele2 and TDC shortly before the regulation on cost-based interconnection charges was in place. According to this agreement, the sum of local origination and termination charges was almost the same as the minute charge for local telephony. It was therefore possible to compete with TDC only at the long distance market. Since then interconnection charges have declined continuously (See Figure 1).

Figure 1 Local fixed network termination charges (DKK/100)



Source: Danish IT & Telecom Authority

Use of historic costs alone resulted in prices too high to fulfil the ambitions of the National Telecom Agency of being among the cheapest countries in Europe. As the introduction of LRAIC needed some years of preparation, a best practise clause was introduced as a temporary arrangement, and Denmark became immediately among the countries with the lowest interconnection rates.

The introduction of LRAIC led to further reductions for all types of interconnection – except local loop unbundling. As noted above there was plenty of room for the Telecom Authority for manoeuvring in the reconciliation process, and the outcome of the process led, from a political point of view, to a very convenient result. In this context it should be mentioned that mobile operators dominated the group of new entrants at that time . They had a keen interest in low charges for call origination and call termination, while they had less interest in pricing of access to local loop facilities.

Development in interconnection charges are affected by two contradictory trends: Innovations in technology and changes in traffic patterns will result in less traffic in the fixed telephone network and more traffic in IP networks. Innovations in network technology lead to a decrease for all types of interconnection products every time new technology is implemented in the model. In the short run changes in traffic patterns result in annual increases in charges for switched interconnection products such as local termination. These two mechanisms will together result in fluctuations in the final charges. Every third year the National Telecom Authority shall assess the model in order to decide, whether updates beyond changes in traffic assumptions are necessary. The first revision came into practise in January 2006 and led to a substantial reduction in tariffs. A second update is scheduled to take place in 2010.

From 2009, LRAIC will also be used for deciding on mobile termination charges. Also in this case, use of LRAIC will lead to a price reduction (from 0.62 DKK today to 0.54 DKK from May 2009). The National Telecom Agency has played a much more active role in the creation of a mobile LRAIC model, as the agency now have gained more in-house expertise in building such models. However the principle of reconciliation in cooperation with the interested parties has been maintained.

A subject for dispute has been the issue of double coverage of the costs of the local loop. In the Danish LRAIC model, subscribers of fixed telephony cover the costs of the local loop in full. However if the same subscribers also have an ADSL connection, their provider must pay 50% of the same costs. In this way TDC receives 150% coverage. Therefore, new entrants have claimed that they should pay only the additional costs related to enable broadband communication on the PSTN line. This principle is used for instance in Sweden. So far the National Telecom Authority has accepted that the problem is addressed by a special reduced price for customers subscribing both to fixed telephony and ADSL.

The double coverage issue is related to another emerging issue, on how changes in patterns of demand should be reflected in the LRAIC model. The principle in LRAIC is that the costs of producing an additional service increment are shared among the users of this service. For example the costs of shared access should according to this principle include only the additional costs of providing Internet access by use of a local access line, where the fixed costs are covered by the telephone subscription. Partly due to increasing use of IP-telephony, it is becoming more common to have an Internet connection without subscribing to a switch telephone line. The telecommunications network is developing from being a telephone network, where certain data communication facilities are added, to an IP network offering voice communication as well as a host of other services. This implies that new types of network architectures (usually named Next Generation Networks) must be used as reference networks, and that telephony will be just another service increment.

Use of LRAIC has led to substantial reductions in telecom wholesale charges in Denmark. This is in line with the results of a comparative study of use of historic costs or fully allocated costs (FAC), and use of LRAIC (Falch, 2004). This study indicates that countries implementing LRAIC in general are more successful in lowering interconnection charges than countries using FAC. It should, however, be emphasized that the use of LRAIC not per se leads to lower prices. With the current traffic patterns involving less fixed telephone traffic, the use of LRAIC leads to increasing charges for switched interconnection including origination and termination charges. Therefore continuous revisions of the model are needed if the decreasing price trend is to be maintained.

One aspect of the LRAIC modelling that contributes to keep the rates low is the *Most Efficient Operator* principle. This works as a kind of best practise clause, where the efficiency of the incumbent operator is measured against other operators at regular intervals. So far TDC is judged to be 100% efficient. But if future comparisons will prove that other operators are more efficient than TDC, the National Telecom Agency is allowed to reduce costs accordingly, so they reflect the costs, as they would be, if TDC were 100% efficient.

Electricity

A regulatory model should address different objectives that are interrelated and ideally should be handled within a single framework. For practical reasons this is not always possible or even advisable. In their analysis of the experience from British network regulation Jamasb and Pollitt (2007) distinguish between the following objectives:

- Regulation of operational and capital expenditures
- Regulation of network losses
- Regulation of service quality (amount and duration of load losses)
- Regulation of investments
- Today’s regulation should also take into consideration the need of adapting the network to a future supply system with increasing amounts of new (small-scale) generating technologies and more flexible and active demand (so-called “distributed generation”)

Whereas specific instruments have been developed for the first four tasks in the British model the Danish model is only addressing the first one. Measures to improve quality performance will be introduced from 2009 to avoid that improved cost performance is paid by a deterioration of quality of service. However, specific measures to secure cut in network losses and optimal investments are so far not planned to be included in the Danish model. Finally, it doesn’t include measures to encourage the operators to adapt their networks to a future with more distributed generation, which is quite relevant into a Danish context.

As the new regulatory model was only introduced in 2008 it’s yet not possible to assess its results.
In the following we will briefly discuss the failure of the old model – what went wrong – and then proceed with a discussion of selected elements from the new model.

What went wrong with the first benchmarking model?

The Net Volume model is a modified version of the original regulatory model, which was introduced after the liberalization of the Danish electricity supply industry in 2000. The basic benchmarking principles are the same but some key features have either been taken out or are modified. The more important of the first is the abolishment of a general revenue cap. In the old model each network operator got a revenue cap that was a combination of the general cap and an individual cap determined from the benchmarking as in the present model.

Another difference is the inclusion of both operational costs and depreciations into a single efficiency index. Under the old regime separate indexes were calculated. It means that the network operators have more freedom to choose networks with different cost structures and still be efficient as operational and capital expenses are assumed to be fully substitutable.

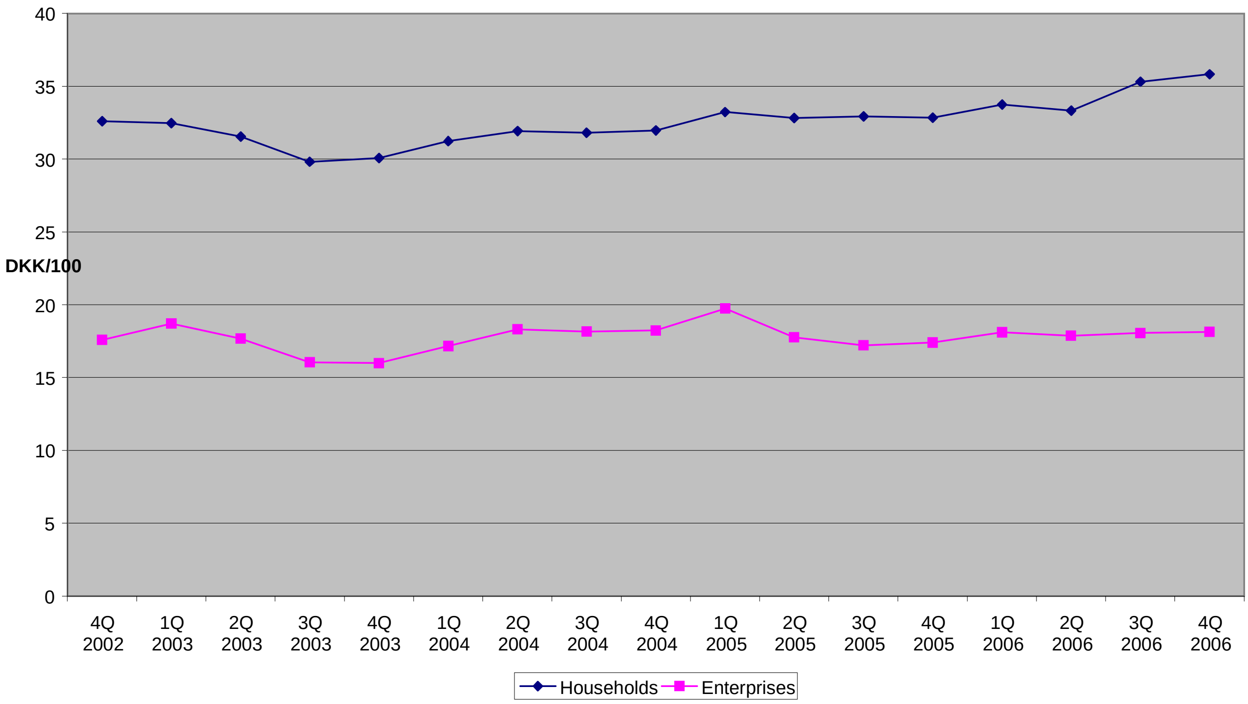
Important is also that the procedure for data collection and the assessment of data quality has been improved. The data applied to calculate the "cost equivalent" for the items included in the Net Volume model are taken from a sample of those network operators with accounts considered of sufficient quality by the external advisor hired by the Authority. This sample covers between 50 and 60% of the total costs of the network operators in the three different groups.

Can the new model be expected to avoid the failures of the old model? The answer to that question depends on the causes of these failures. Were they mainly due to the choice of model or was it during the implementation of the model that things went wrong?

A study of the first regulatory period 2000-2004 concludes that it was the implementation process that went wrong (Sørensen 2005). Under the former cost-plus regulation the distribution utilities were obliged to break even each year. However, the investment costs of for instance a new transmission line could be written off during up till 5 years before it was commissioned. Because of that most utilities had very little debt at the time of liberalization. However, under the new regime they were allowed to recalculate the value of their assets according to the estimated lifetime, which resulted into an enormous increase in their values. This process was chaotic but the revalued assets were accepted as the basis for the calculations of the net volume for the unbundled network operators and of their revenue cap. In addition, the regulator was inexperienced, had a too small staff and was under time pressure. Because of the tradition of co-operation under the former regulatory regime the new Energy Market Authority didn't expect the network operators (organized either as municipal enterprises or consumer co-operatives) to behave strategically, which they did. Finally, the political signals changed during the period of implementation from a tough approach to regulation anticipating large efficiency gains towards a more soft approach. A winter storm provoking many blackouts was the immediate cause of this change.

Because of these failures the expected large increases in productivity were not achieved. Network prices (only distribution) were more and less constant from 2002 to 2006 and even increased slightly for households as can be seen from the figure.

Figure 2 Quarterly (real) distribution net prices (DKK/100 per kWh) 2002-2006*



* Own calculations using data from the Danish Energy Authority[5]

[5] The network prices from 2007 cannot be compared with those from before because of changes in the methodology.

As the introduction of the new regulatory model has been much better planned it can be expected to achieve better results. In a way the Danish experience with chaos and higher prices during the first introduction of incentive regulation is not so different from that reported from the UK (see Jamasb and Pollitt 2007) and Norway (see Bye and Hope 2005).

Some specific features of the Net Volume model

In the following we will briefly discuss a few features of the new Danish model that can be considered problematic and subject for further analysis. That will include investment incentives for investments, incentives to reduce energy network losses and the exclusion of economies of scale from the model.

The incentives for investments are a very important issue in other countries, which is often handled by specific incentive schemes (see Jamasb and Pollitt 2007; Joskow 2006). This is not the case in Denmark. The incentives to invest are only briefly discussed in the report presenting the model (Energitilsynet 2007, Bilag 9). The report concludes that the model will not have significant negative impact on the incentives to invest but leaves the issue without any detailed analysis. According to the Energy Market Authority the combination of both operational costs and capital costs in the efficiency index together with the inclusion of quality of service in the benchmarking from 2009 will provide the right incentives to invest.

There is one exception. A network operator can apply for having some of its investments such as providing new areas with electricity or substituting overhead lines by cables accepted by the Authority as “necessary”. As a higher rate of return is allowed for such investments the operator is provided with an incentive to invest and thus to increase its average rate of return on invested capital.

Substituting the components of the existing network with a new network means lower operational costs and higher capital costs. A rational network operator is expected to invest in new components when this trade-off has a positive outcome. Decreased energy network losses are one of the expected effects of the investment. It appears strange that the cost of these losses is excluded from the Danish benchmarking and, therefore, doesn't function as an investment incentive. The argument by the Energy Market Authority that losses cannot be influenced in the short term is not convincing as the model is expected to provide incentives that are consistent with long-term efficiency.

The new Danish model assumes *constant returns to scale*. Either this is a correct representation of reality or the benchmarking provides the regulated network operators with an incentive to become bigger. Studies of distribution utilities report different results for the impact of scale on efficiency (see Pollitt 1995, Chapter 8). In a DEA-analysis of Danish distributors (before the unbundling that took place after the electricity reform in 2000) Hougaard (1994) didn't find significant economies of scale.

We calculated the correlation between the efficiency ranking for 2008 and the size of the DSOs, which showed no significant relationship and thus confirmed the results from the 90ies. Size was measured both as the number of connected meters and supplied GWhs.

To test the robustness of its regulatory model the Energy Market Authority recalculated efficiency applying other models (DEA, Farrell Efficiency, SFA etc.). The resulting ranking was compared with the ranking from the Net Volume model, which provided a correspondence varying between 0.9 and 0.3.

Can the two network industries learn from each other?

The two infrastructure industries have developed very different approaches to the regulation of access prices. Is this accidental because of different historical traditions (what is called "path dependency" by the political scientists) or can it be explained by key characteristics of the two industries and their particular conditions? If it is the first they can learn from each other.

The UK is an example of a country where the same regulatory principle, the price cap model has been applied to a number of infrastructure industries (see Armstrong et al., 1995). To our knowledge this is a unique case[6]. In other countries including Denmark there has never been any common framework for the regulation of these industries (see Henten et al. 2008).

A number of features distinguish telecommunications and the electricity supply industry from each other. The technologically determined vertical separation of competition from monopoly (generation and sales from network operations) is obvious in the electricity industry. It is from time to time being considered in telecommunications, but has so far not been implemented. Technological development is much faster in telecommunications and influences the borderline between network infrastructure and services, which is far from as clear as in the electricity industry.

Because of vertical integration regulation of access pricing in telecommunications has become a game with the regulator, the incumbent operator and its competitors as the players. Technological development makes the historic costs of the incumbent's infrastructure increasingly irrelevant, which is the background for the LRAIC-model. In practice, access pricing in Denmark has developed into an ongoing bargaining between the incumbent TDC and its competitors with the regulator as an arbitrator. Conflicting interests between different types of new entrants further complicate this game. While mobile operators primarily are interested in reductions in termination rates, broadband operators have their focus on local loop unbundling and bit stream access.

The game is very different in the electricity supply industry because of vertical separation. Network technology is not changing very rapidly as in telecommunications, wherefore benchmarking using actual costs of the existing network is less problematic. The network operators are not competing with each other

[6] When Germany after the EU market directive from 2003 was forced to introduce sector regulation of the electricity supply industry the telecommunications regulator had its role extended to include energy.

and have common interest in getting a favorable regulation model. Therefore, the game is much more between the regulator and the industry as a common actor.

These differences don't preclude practical experience from one of the industries to be applied in the other even if it narrows the scope for such exchanges. There are of course a number of practical issues such as the collection of reliable data and the construction of relevant indicators and how to avoid regulatory capture that can be learned. In addition, it's not inconceivable for one of the infrastructure industries to apply models developed for the other. Benchmarking models have been applied in telecommunications (cf. above about the use of "best practice" in Denmark) and so have models like LRAIC in the electricity supply industry (the Swedish Network Performance Assessment Model is a case of that, see Jamasb and Pollitt 2008). The future requirements of adapting to distributed generation and flexible demand can also make this exchange of experience more relevant.

References

Agrell, P., P. Bogetoft and J. Tind (2005), DEA and Dynamic Yardstick Competition in Scandinavian Electricity Distribution, *Journal of Productivity Analysis*, 23, 173–201.

Armstrong, M., S. Cowan and J. Vickers (1995), *Regulatory Reform: Economic Analysis and British Experience*, Cambridge, MA: MIT Press.

Bye, T. and E. Hope (2005), Deregulation of electricity markets - The Norwegian experience, *Discussion Papers* No. 433, September 2005, Statistics Norway, Research Department.

Energimyndigheten (2004), Nätnyttomodellen, *Beslut* 2004-06-21, Eskilstuna.

Energitilsynet (2007), *Effektiviseringskrav til elnetselskaber for 2008* (www.energitilsynet.dk/afgoerelser-mv/4/elektricitet/afgoerelser-el/effektiviseringskrav-til-elnetselskaber-for-2008/)

European Commission (1998), *Recommendation 98/511/EC of 29 July 1998 on interconnection in a liberalized telecommunications market* (Part 1 - interconnection pricing)

European Parliament (1997), *Directive 97/33/EC of the European Parliament and of the Council of 30 June 1997 on Interconnection in Telecommunications with regard to ensuring universal service and interoperability through application of the principles of Open Network Provision*, Official Journal, L199, 0032/0052.

Falch, M. (2004), Cost based interconnection charges, competition and investments, WDR Dialogue Theme 2003, *Discussion Paper* WDR 0308

Freund, N.and E.-O. Ruhle (2002), *Regulatory concepts for fixed-to-fixed and fixed-to-mobile interconnection rates in the European Union*, The 17th European Communications Policy Research Conference, Barcelona 2002

Hougaard, J.L. (1994), Produktivitetsanalyse af dansk elproduktion, *AKF rapport*, 1994

Jamasb, T. and M. Pollitt (2007), Incentive regulation of electricity distribution networks: lessons of experience from Britain, *Energy Policy*, 35, 6163–6187.

Jamasb, T. and M, Pollitt (2008), Reference models and incentive regulation of electricity distribution networks: An evaluation of Sweden's Network Performance Assessment Model (NPAM), *Energy Policy*, 36, 1788–1801.

Joskow, P.L. (2006), Incentive regulation in theory and practice: electricity distribution and transmission networks, *Cambridge Working Papers in Economics* no. 0607 and *Electricity Policy Research Group Working Paper Series* no. 0511.

National Telecom Agency (2002), *Common Guidelines for the Top-Down and Bottom-up Cost Analysis*, Copenhagen

NVE (Norwegian Water Resources and Energy Directorate) (1997), *Incentive-based regulation of electricity monopolies in Norway - background, principles and directives, implementation and control systems* (http://nve.no/FileArchive/185/paperonregulalation.pdf)

NVE (2007), *Ny økonomisk regulering av nettselskapene fra 2007* (http://nve.no/FileArchive/185/paperonregulalation.pdf).

Olsen, O.J., A. Henten and M. Falch (2008), Regulatory Reform of Public Utilities in a Comparative Perspective – The Case of Denmark, *Competition and Regulation in Network Industries*, 9, 101-118.

Pollitt, (1995), *Ownership and Performance in Electric Utilities*, Oxford University Press: Oxford.

Shleifer, A. (1985), *A theory of yardstick competition*, Rand Journal of Economics, 16, 319-27.

Sørensen, E.M. (2006), Indtægtsrammeregulering i den danske elreform, *AKF Working paper*, december 2005, Copenhagen (www.akf.dk/workingpaper).

Vogelsang, I. (1988), Price-cap regulation of telecommunications services: A long run approach, in M.A. Crew (ed.), *Deregulation and diversification of utilities*, Boston: Kluwer.