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NEMESYS Project: A Pan-Nordic Approach to Regulation of Distribution System Operations

FINAL REPORT

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Disclaimer

This is the final report within the Nordic Efficiency Model for Electricity distribution SYStems (NEMESYS) project under coordination by SUMICSID AB for Nordenergi. Project leader for the NEMESYS project has been prof. Per Agrell, SUMICSID AB. The project has involved the consultants prof. Per Agrell, SUMICSID AB, Jørgen Bjørndalen, SKM Energy Consulting, prof. Peter Bogetoft, SUMICSID AB, Helle Grønli, EC Group AS, Pontus Roos, RR Institute of Applied Economics and Mikko Syrjänen, Gaia Group OY, in alphabetic order.

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Summary

The Nordic countries share a long tradition of business development, institutional reforms and common values in both private and public enterprises. Starting from national and introvert electricity sectors, the Nordic countries can now also share the pride over one of the most successful deregulations of the electricity sector. Yet, there remains a regulated vertical segment displaying a wide range of solutions, both institutional and instrumental.

In a European context of increased mobility, standardization and transparency, the Nordic countries usually lead the way in terms of solutions. The NEMESYS project investigates the possibility of a harmonized approach to DSO regulation.

As the governments separately prepare to revamp their national regulation for the new EU directive, the NEMESYS project presents a new harmonized regulatory approach, that respects and clarifies the roles and particularities of grid operators, regulators, owners and clients. The proposal has been carefully analyzed from all stakeholder perspectives to assure feasibility and incentives for action. The lead issues that have been addressed are investment incentive provision, output focus and quality of service.

The distribution business is facing large investment needs and the new regulation must create an attractive environment for investors and managers to run, maintain and develop the operations. The new regulation must also break with the "micro-management" tendency and concentrate on the issues related to the value for money that clients desire. Quality is to be promoted using monetary incentives related to customer value wherever possible, not detailed restrictions.

The NEMESYS proposal is based on two strong components: a revenue yardstick model and a quality incentive scheme. The yardstick regime is a modern implementation of an intuitively attractive principle. In a bold stroke, it cuts the Gordian knot of efficiency and investment provision, asset valuation, and capital cost estimation. Rather than basing the efficient revenue on historic cost, it uses the actual revenues charged for the actual services, including capital costs, provision for future investments and competitive managerial incentives. It is shown that the integration of benchmarking based on flexible frontier models in the yardstick provides incentives for tariff reductions, efficiency improvements and investments. The quality incentive scheme complements the yardstick by creating a simple and customer-oriented compensation system for quality service.

In the Nordic spirit of modernism and simplicity, the NEMESYS approach is perhaps the answer to the question that is waiting to be asked.

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1. Introduction

Background

1.01 Nordenergi, the industry association for electricity sector in the Nordic countries, has commissioned an international study to analyze the possibilities for a common regulation model for electricity distribution in the Nordic region (NordPool region).

Objectives

1.02 The goals of the study are to:

1) Evaluate the advantages and disadvantages of a pan-Nordic regulation model and benchmarking tools viewed in all perspectives of the stakeholders, i.e. customers, society, regulator, owner and distribution system operator.
2) Identify the most critical factors in cross-border regulation and benchmarking
3) Propose a common model for regulation and benchmarking of electricity distribution companies.

1.03 In addition to the stakeholder objectives and the critical factors, the proposed common model should also reflect anticipated European electricity directive changes as well as the national regulatory objectives. Implementation of a common model will imply harmonization of national legislation.

1.04 In addition, the proposal must address the general challenges related to the economic regulation of natural monopolies. Thus, the ideal regulation model should provide:

1) Incentives for efficiency improvements
2) Incentives for tariff reductions
3) Incentives for customer oriented quality improvements
4) Incentives for sound industry structural changes
5) Capital recovery and competitive return for owner-financers of network assets
6) Long-term regulatory commitment on principles
7) Optimal allocation of decisions and information to avoid micro-management
8) Objective firm-level performance assessment

1.05 The proposal should also address the Nordic sector-specific challenges like systematic cost differences, environmental factors and differences in accounting principles and legislation.

1.06 The objective of the study is to adequately and convincingly address these issues to achieve a regulation model with a socially and economically acceptable compromise among the conflicting criteria, such that no other model can unilaterally improve on all criteria.

Authorship

1.07 The final report provides a synthesis and complement to the previously released reports from subprojects A (System Analysis, 2005-04-22), B (Mechanism Design, 2005-06-23) and C (Nordic Efficiency Model, 2005-06-29).

1.08 Project leader for the NEMESYS project has been prof. Per Agrell, SUMICSID AB. The final report is jointly authored by the participating consultants prof. Per Agrell, SUMICSID AB, Jørgen Bjørndalen, SKM Energy Consulting, prof. Peter Bogetoft, SUMICSID AB, Helle Grønli, EC Group AS and Mikko Syrjänen, Gaia Group OY, in alphabetic order. Project member Pontus Roos, RR Institute of Applied Economics has contributed to subproject C.

1.09 The final report acknowledges frequent and constructive contributions from the NordEnergi Working Group on Regulation, with the members Lars-Ake Gustafsson, Kenneth Hänninen, Bent Johan Kjær, Kari Koivuranta, Jouni Lehtinen, Lars Ohlsson, Torben Møller Pedersen, Anders Pettersson, Ketil Grasto Røn, Jan Sundell, Trond Svartsund (in alphabetic order).

1.10 The NEMESYS project has organized three workshops during the process, 2005-03-01 (Project Planning), 2005-04-22 (Means, ends and challenges in Nordic electricity network regulation), 2005-06-10 (Modeling and regulating Nordic electricity distribution). Before each workshop, draft versions of reports were circulated to promote discussion. Interactions during and following the workshops with participants from regulators and the sector have also contributed to this report.

Outline

1.11 The report is structured as follows. Chapter 2 gives a brief introduction to state-of-the-art regulation and proposes a systematic way to evaluate the pros and cons of the different approaches. Chapter 3 pursues the analysis of the most promising instrument, yardstick competition. The theory behind quality regulation instruments is summarized in Chapter 4. The theoretical analyses in 2-4 lay the basis for the full proposal to a regulatory approach that is presented in Chapter 5. The proposal is then analyzed in detail from firm-level perspective (Chapter 6), policy level (Chapter 7) and investor-owner perspective (Chapter 8). A short note on regulatory transition is provided in Chapter 9, followed by a concluding summary in Chapter 10.

1.12 Readers familiar with regulation theory in general, and yardstick frontier competition in particular, may proceed directly to Chapter 5. For those that have followed the earlier reports (A, B, C) in the NEMESYS project, note that additional material has been added also to Chapters 2 and 3, in addition to the new analyses in Chapters 6-8. Finally, for those that are merely interested in the argument base for the proposal, Chapter 10 effectively summarizes the preceding presentation.

2. Regulatory tool-box

Why regulate?

2.01 The guiding principle for all economic activity in the Western society is the *market*. Network activities, such as distribution of electricity or water, are examples of natural monopolies or market failures. For electricity distribution, the monopoly is accentuated by (i) the existence of a single supplier of the service for each customer, (ii) no substitute for the offered service and very low price elasticity, and (iii) high economic and legal barriers to market entry.

2.02 In addition to the desire to incite productive and allocative efficiency, there may be non-economic reasons to impose regulation on a network industry. Attention paid to public safety, continuity of supply, public service obligations, environmental externalities and information disclosure are examples of such objectives.

2.03 Thus, in return for granting exclusive monopoly rights, for a limited or unlimited period of time, the society empowers a regulator to act as a proxy purchaser of the service, imposing constraints on the prices and the modalities of the production. Friedman (1962) clearly states that a natural monopoly *per se* does not necessitate a legal monopoly; it is merely a transient phase in the technological development. Any policy that blocks, hampers or discourages efficient entrants from market access is economically detrimental, cf. Demsetz (1968).

The regulator's problem

2.04 In modern economic theory, the regulatory problem is expressed as a game between a principal (the regulator) and a number of agents (the regulated firms). The objective of the regulator is to maximize social welfare, which may be thought of as the difference between the sum of consumers' and the firms' utilities (profit) and the total costs incurred. Immediately, it is clear that minimization of costs is a societal priority, as well as the inevitable trade-off between the consumer and industry interests. The objective of the regulated firms may be maximization of surplus, which in addition to monetary profit also includes managerial utility (effort level, benefits and conditions).

2.05 The availability and access to information is a key issue in the regulatory game. With perfect access to information, the regulator could impose socially optimal price and service quality. However, the information is *asymmetrically* distributed between the regulator and the agents. The regulator faces a double asymmetry, where neither efficient costs, nor optimal efforts are verifiable. Costs and prices in the natural or legal monopolies are not true reflections of supply and demand, but are set by the actors themselves in a monopoly– oligopoly setting. Since the regulator has an information disadvantage against the agents, the attainable goal of the regulation cannot be to implement the first best competitive solution, but merely to *mimic* the market by carefully using elicited information. We claim that the closer the regulation gets to market functions, the less harmful it will be in the long run through the distortion or incentives, information and production. Facing efficiency improvements, innovation and technical development, a mis-specified regulation will be likely to dampen progress and achieve lower social welfare.

Price or restriction based regulation

2.06 While much of the economic literature stress the regulation via compensations and reimbursements, must regulators also interfere much more directly in the operations of the firms. This corresponds to the dual use of prices and restrictions. The correct balance between the two methods is not well studied in the literature and often left to regulatory institutions' discretion.

2.07 An important instance of restriction based governance is the *regulation by rights* concept that is extensively used in e.g. environmental regulation. Here, the regulator designs a mechanism under considerable uncertainty regarding the future technology in addition to the information asymmetry. Mechanisms with ex-ante rules, usually certifications and detailed instructions on the production, distribution, use and disposal of hazardous materials or processes, are extensively used in European contexts. The regulator takes a considerable risk from the firms in a trade-off between the moral hazard of asymmetric information and the risk of opportunistic behavior on behalf of the firms. Generally, the regulation is extensively process-oriented and suffers from problems of technology lock-in with time.

2.08 Another illustration of the role of restrictions is the use of a broader set of *individual and collective liabilities*, specifying undesirable outcomes that, irrespective of process, may imply claims of compensation. In such an approach, the firms freely select their investments and operations to maximize profits while avoiding liability claims. Rather than micro-managing the firms, the regulator is now challenged with the task of monitoring the final outcomes of production and assuring that liability claims are enforced. In the American common law system, this has lead to substantial punitive damages being paid by ex-post negligent firms. However, if firms can avoid paying liabilities or pay them through taxes etc. the system cannot guarantee the optimal investment and service level. An illustration to this phenomenon is found in telecommunication regulation of fixed networks. If concessions are awarded based on lowest price subject to an ex-post level of service (coverage, failure rate, etc.), an opportunistic firm can win the contract by neglecting investments and then cease to exist when/if damage is observed. To limit this risk, regulators demand frequently the posting of a bond (e.g., shares of stock, assets or other profitable concessions) to offset the consumers' risk.

Dynamic regulation

2.09 Regulation is a long-term game, and short run profit extraction by the regulator does not suffice to ensure a successful long term development of an industry.

2.10 Many industries with natural monopolies depend strongly on large and very specific capital investments. This makes such industries amenable to problems of opportunism and if long terms conditions are not ensured, under-investment will result. Electricity distribution is a classical example. It is an infrastructure industry with strong dependency on capital investments, low marginal cost and strong network externalities in grid expansion and operation. The technical and economic life of the average network asset largely surpasses any regulatory period, if not the tenure of the owners and regulation itself. Yet, investments have to be undertaken sequentially and costs allocated into an uncertain future, which naturally puts the attention of the managers and owners to the regulation.

2.11 Part of the difficulty for the regulator and the firms to anticipate future costs and revenues is linked to the endogeneity of the technology and market development. The allocation and total amount of rents that the regulator leaves to the industry determines the potential for internal process development and innovation, as well as structural changes in the type, size and scope of firms in the market. A regulation focusing on profit control leading to low short-run consumer tariffs may in practice be associated with risks of halting process innovation, improvement and management recruitment.

2.12 The endogenous character of regulation, industry response and market/process development is illustrated in Figure 2-1 below, where the exogenous influences from technology/market innovation and market entry are indicated.

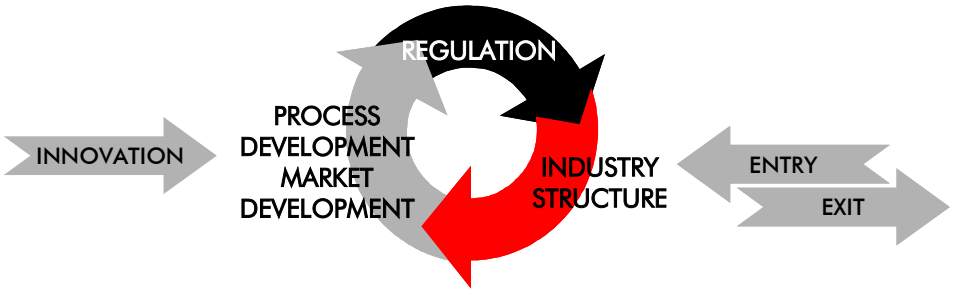

Figure 2-1 Dynamics of regulation, innovation and industrial structure.

2.13 The anticipation of future regulation is inevitable, as the investments carry so far in time. Thus, in the absence of information on possible regulatory changes, historical and imperfect information on political and economic tendencies become influential in the investment decisions of firms. This uncertainty is counterproductive, as less informed decision-makers are forced to anticipate reactions of regulators, who in their turn are eagerly awaiting the decisions of firms to monitor the regulation. The wheel of information in Figure 2-1 can in this way be both a positive cycle of improvements and adaptation, or a negative cycle of uncertainty and under-performance.

2.14 This suggests that a long term plan for regulatory reforms may be advantageous. The optimal regulation will depend on the industry structure etc. which in term will be affected by the incumbent regulation and gradually may necessitate a new regulation.

Regulation Approach: Elements

2.15 Below, we will clarify some key elements in regulation mechanism design. We start be discussing the differences between *regulatory approach*, *regulation institutions, regulation mechanism* and where the choice of ex-ante or ex-post belongs. The concepts are illustrated in Figure 2-2 below, where the boxes delimit the definitions.

2.16 By *approach* we mean an entire system consisting of a defined market (regulated clients and their roles), an industry (firms, assets, technology) and the corresponding institutions (regulator, courts, associations, etc.) that administrate the regulation. This part of the approach is called institutional design and is very important albeit largely beyond the focus of this project, where the institutional settings are considered given.

2.17 Given a certain institutional solution, the regulator chooses a *mechanism* to define the relations between the players. The mechanism design with its elements is initiated below and extended below when we discuss different classical packages. Note that the distinction is far from self-evident, as an identical mechanism (say, a price cap) can give very different social welfare results depending on the institutional design.

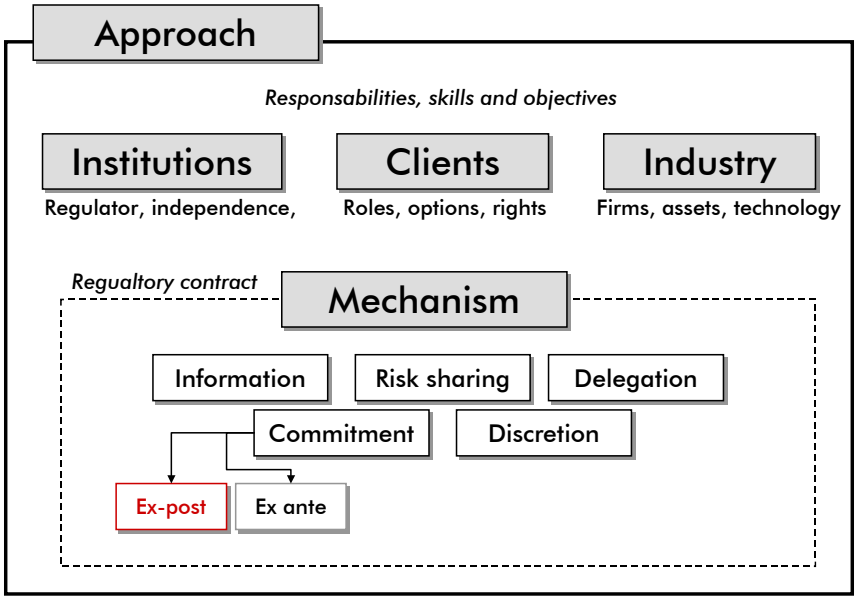

Figure 2-2 Regulatory approach, institutional design and mechanism design.

2.18 In new regulation economics (cf. Laffont and Tirole, 1993), the regulation system is modelled with detail that allows each stakeholder; the firm's manager, the firm's owner, the client, the regulator and the government, to outline their own dynamic strategies and to respond strategically to the actions of the other players. The "rules of the game", i.e., the actual regulation regime, are modelled as an *economic mechanism*, where it is important to clarify exactly who make decisions, when they are made, how the information is distributed and to which quality, and the options of the players. Here, we shall focus at five key elements: *information, risk sharing, discretion/automatics, delegation* and *commitment*.

Information

2.19 Information can be classified with respect to initial distribution (public, private), observability (can it be acquired?) and verifiability (can it be contracted upon?). Regulation of networks is a classical example of private information on behalf of

the firms, where the complexity of the system and the multitude of services offered put the regulator at a disadvantage when it comes to determining, e.g., the true minimal cost of operations or the optimal level of investment. However, we should not forget the private information that the regulator possesses in terms of fiscal policy and aggregated information about future demand that could be used to extract rents from the firms.

Risk sharing

2.20 Risk sharing relates to how the exogenous risk (market, technology, climate) is carried by the regulator, the firms and the clients. Although network operations are considered as low-risk businesses, the distinction is meaningless without reference to the other elements in the mechanism, primarily the expected long-run profit contribution that is left to the firm.

Discretion

2.21 Discretion/automatics are two extremes on an interval of regulatory enforcement. A mechanism that prescribes a well-specified act for each state of nature and action by the firm is an example of a complete contract or an automat. Discretion, on the other hand, gives more or less freedom to the regulator to assess, reimburse or penalize the firm under certain conditions. Of course, regulatory discretion introduces an endogenous risk, the regulatory risk, into the mechanism, which has two effects. First, the firm may demand a higher expected profit to participate in the mechanism, fearing arbitrary expropriation of profits. Second, a limited discretion with a predictable focus may induce less manipulation of incomplete contracts. An example could be use of a costly audit in a cooperative setting, where the members actually imposes the arbitrariness to deter fraud with a minimal cost. However, to be effective, the regulator needs to voluntarily limit the discretion of its staff.

Delegation

2.22 Delegation of decision rights is specifying who may initiate actions, e.g., deliver services, undertake investments and sign long-term contracts. In a centralized system, the regulator retains the decision rights and gives specific orders to agents how to perform the services. A classical decision right issue in network regulation in this context is *investment review* and *pricing*. As we will see, a formalized (automatics) mechanism that removes the investment risk (risk allocation) and provides the firm with a guaranteed return, such as cost-plus, is normally balanced with a centralization of the investment decision to avoid abuse. Similarly, a regulator with social (redistributive) objectives may wish to centralize the pricing decision to assure regional and social equity. Somewhat simplified, one may say that a higher decentralization of decisions increases the coordination gains due to local information, but at the potential expense of motivation costs due to asymmetric information.

Commitment

2.23 Commitment is the term that is used to express whether the regulation mechanism is a long-term or short-term contract. As network concessions by nature are long-term relations with the regulator, short-term contracts are interpreted by the firm

as a signal of upcoming renegotiations, where the acquired information in the current period may be used to extract rents. On the other hand, the regulator cannot engage in long-term contracts without possibility of renegotiation unless it had perfect forecasts of demand, technology and prices. At the very core of regulatory design we find the appropriate use of renegotiation in the mutual interest of regulator and firms.

A small model

2.24 Consider a general mechanism for a regulator and a firm over two periods. The regulator has the opportunity to use some information y_0 about the agent (ex ante) and/or to observe some information y_1 from other agents in the next period (ex post). The regulator may now propose the following contract for the first period:

$$R = c_1 + \rho[c(y_0,y_1) - c_1]$$

where R is the allowed revenue in period 1, c_1 the realized costs in period 1, and $c(y_0,y_1)$ is the modeled cost norm.

Incentive power

2.25 In the model above, we call ρ the incentive power. For a *high-powered* contract, let's say $\rho = 1$, the firm receives $R = c(y_0, y_1)$ whatever its own costs are. Since the firm cannot affect the information that the contract is based on (it could be the regulator's own data or the competing firms), it has strong interest to reduce its own costs c_1. On the other hand, if the regulator has poor information y_0 before that contract and no ability to use the later information (perhaps there are no other firms), the regulator may propose a *low-powered* contract $\rho = 0$ where the firm gets $R = c_1$, i.e., realized costs corresponding to a cost-plus regime. In this situation, the firm has no incentives to reduce cost, but the regulator is sure that the rent (profit) paid to the firm is not excessive. In theory, one may guess that c_1 would be infinite unless the regulator has some imperfect information y_1 that at least limits the inefficiency to some upper bound, which is the case in reality.

Ex-ante / Ex-post

2.26 The new IEM directive refueled the discussion on the sequence of information acquisition and commitment, namely the issue of *ex ante* versus *ex post* regulation. As this is some importance in the upcoming proposal, we will explain the concepts using the simple model above. A further analysis of the issue, based on the final proposal is given in Chapter 7 (cf. 7.50).

2.27 In an ex-post regulation, the regulator would freely use the information y_1 to decide how much to pay the firm. Depending on how y_1 is acquired and the incentive power, this may put more or less risk on the firm. E.g., an ex post cost-plus regime has $\rho = 0$ and a yardstick regime $\rho = 1$. The point is that the exact reimbursement is unknown at the time of production, but provided that the mechanism is not completely discretionary, its structure is known. In an ex-ante regime, the regulator would promise not to use any revealed information, thus the contract would be of the kind $c(y_0,-)$.

2.28 The Nordic countries have rather many and small distribution companies with mixed-ownership and a long tradition of common objectives in the electrification of the countries. Due to a heavy dominance by publicly owned firms, the former regulation regimes were low-powered and light-handed, since the state preferred to minimize the regulatory costs and trusting the common objectives to assure optimal decentralized decisions. High-powered regimes would have been misplaced in this very homogenous context, basically leaving the regulation to the largest incumbent state-owned firm. With the deregulation and the unbundling of the electricity industry, the situation changed towards higher heterogeneity on behalf of the firms and the customers. The generators, subject to a competitive market and increasingly under private or foreign ownership, could no longer be assumed to carry implicit and complete responsibility for the market functioning. Thus, changes in one sector inevitably carries over to nearby sectors and to the expectations and objectives of the regulatory system. It is from this perspective we believe that a change of mechanics in regulation should be considered in a structured and systematic way without resorting only to simplistic model.

Classical approaches

2.29 The regulatory toolbox contains numerous more or less ingenious solutions to different instances of market failure. The set of tools that theorists and practitioners can think of expands every day. To get started, however, we outline some of *the basic elements* in a regulatory design. Also, we may sketch some *classical regulatory packages*. Starting from state of the art in the practice of regulation and moving towards state of the art in the theory of regulation, we shall discuss five types of regulatory mechanisms here, namely

1) Cost-recovery regimes (cost of service, cost-plus, rate of return),
2) Fixed price (revenue) regimes (price-cap, RPI-X),
3) Yardstick regimes,
4) Concession auctions regime
5) Technical norm models.

Cost-recovery regimes

2.30 Taking the cost information supplied by the agents for granted the regulator may choose to fully reimburse the reported costs, often padded with some fixed mark-up factor. To illustrate, the reimbursement in a given period may be determined as

$$R = c_o + D + (r + \delta)K$$

where c_o is the operating expenses , K is the capital (rate base), D is the depreciation of the capital reflecting capital usage, r is an interest rate reflecting the capital costs of investments with similar risk and δ is a mark-up.

2.31 Unless subject to costly information verification (regulatory administration), the approach results in poor performance with skewed investment incentives (no investment risk, yet fixed return on investment), perverse efficiency incentives (loss

of revenue when reducing costs) and lack of managerial effort (distorted market signals and limited managerial rewards).

2.32 In reality, such schemes have involved considerable regulatory administration trying to avoid imprudent or unreasonable operating expenditures or investments to enter the compensation and rate base. However, even with large investments in information gathering, the information asymmetry and the burden of proof resting on the regulator still cripple the efforts to induce efficiency.

2.33 Regulatory authorities worldwide, also in the USA, are gradually abandoning these regimes as administratively costly and technologically inadequate.

Fixed price regimes (price-cap, revenue cap, RPI-X)

2.34 In response to the apparent problems of the cost-recovery regimes, Littlechild (1983) launched a so-called high-powered regime allowing the regulated firms to retain any realized efficiency gains. In the price-cap regime, the regulator caps the allowable price or revenue for each firm for a pre-determined period. Based on a review period, a model of likely development in costs are developed, and this model is used to fix the revenue or price baskets for a typically 4-5 years regulation period. The model is usually quite simple, involving a predicted productivity development per year X plus perhaps individual requirements on firms, say X_i , to reflect the level of historical costs and hereby the need to catch up to best practice. The resulting allowed development in the revenue for firm i is then

$$R_i(t) = C_i(0)[1 - X - X_i] \text{ for } t = 1, \ldots, T$$

where $R_i(t)$ is the allowed revenue in period t and $C_i(0)$ is the cost of firm i in the base period 0. There are of course many modification to this model and we shall consider some more specific ones later. The crucial things to observe at this stage however is the fixed (performance independent) payment which is the key to the incentive to reduce costs, and fixation of payments for a regulation period and hereby a regulatory lag in the updating of the productivity development. The last feature is often emphasized by calling such schemes ex ante regulation as illustrated in Figure 2-3 below.

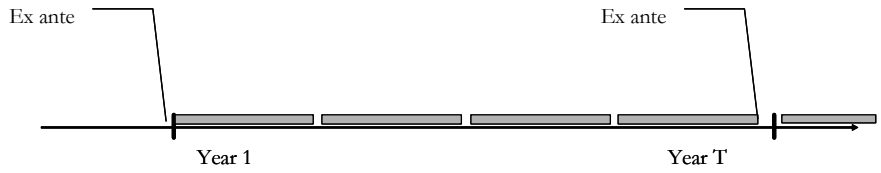

Figure 2-3 Ex ante revenue cap

2.35 As observed, the performance independent payment - effectively making the firm the residual claimant - is the key to the incentives: to maximize profits, the firms minimize their costs and optimize their efforts, achieving cost efficiency. However, in practice, the revenue cap is regularly reset with hindsight to the realized profits in the past period.Since efficient operations may therefore lead to more demanding conditions in the future, this so-called ratchet effect will lower the efficiency incentives. Indeed, recent empirical research (Giulietti and Waddams-Price, 2000) has shown that utilities indeed do play strategic games under revenue-cap regimes in anticipation of future cap reviews. Another difficulty is the initial price/revenue level when firms initially charge differing prices. Either the conditions are homogenous, in which case the price differences reflect inefficiency, or the price levels reflect heterogeneous delivery conditions. In any case, the initial price caps would have to strike a careful balance between informational rents, incentives for restructuring and the bankruptcy risks.

2.36 Further, the price cap is usually linked to the consumer (CPI) or retail price index (RPI) as a measure of inflation, and in spite of its conceptual transparency and autonomy, the initial caps, the periodicity of review and the determination of the X-factor face the regulator with the same challenges as other solutions. In particular, since initial windfall profits are retained by the industry and dynamic risks are passed on to consumers, there is a potential risk of regulatory capture by consumer or industry organizations.

Yardstick regimes

2.37 The idea behind yardstick regimes is to mimic the market by using real observations to estimate the production function. Thus for example, in its simplest form, the allowed revenue for firm i in period t would be set ex post and be determined by the costs in the same period of others firms $j = 1, \ldots, i-1, i+1, \ldots, n$ operating under similar conditions

$$R_i(t) = \frac{1}{n-1}\sum_{j \neq i} C_i(t) \text{ for } t = 1, 2, \ldots..$$

The regime is attractive in the sense that the revenue of the firm is not determined by his own cost, but by the performance of the market (the other firms). The scheme is therefore effectively a fixed price scheme making the firm a residual claimant like in the Revenue Cap model above and this is the key to the incentive properties. The second crucial feature is that the allowed revenue is

determined ex-post, i.e. after each period. This is illustrated in Figure 2-4 below. Exogenous and dynamic risks will directly affect the costs in the industry, lifting the yardstick. Innovation and technical progress will tend to lower the yardstick. Thus, the regime endogenizes the ubiquitous X factor and caps the regulatory discretion at the same time.

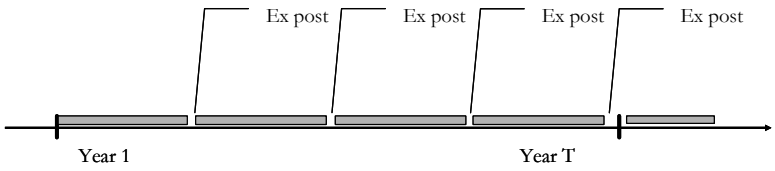

Figure 2-4 Ex post revenue cap

2.38 Lazear and Rosen (1981), Nalebuff and Stiglitz (1983) and Schleifer (1985) show condition for the implementation of first-best solutions for correlated states of nature. The results carry over even for imperfectly correlated states of nature (Tirole, 1988). Hence, the comparators do not have to be identical, but the relative difference in the exogenous operating conditions has to be known.

2.39 However, the pure approach, only to consider the observed cost in each period, is attached with some risks in implementation. First, a set of comparators or correlated operating conditions has to be established. Second, if the comparators are few and under similar regulation, there is risk of collusion. Finally, a yardstick system that is not preceded by a transient period of asset revaluation or franchise bidding will face problems with sunk costs and/or bankruptcy. The crucial question in terms of yardsticks in electricity distribution is how to preserve the competitive properties while assuring universal and continuous service.

2.40 In Chapter 3, we expand on the advantages of the yardstick idea showing how to cope with cases of imperfectly correlated costs and with variations in output levels and mix by using recent developments in performance evaluation techniques, including DEA.

Concession (franchise) auction regime

2.41 A simple mean to elicit accurate cost information while assuring participation is to arrange franchise auctions (Demsetz, 1968, Laffont and Tirole, 1993, Baldwin and Cave, 1996). The idea is to award the delivery rights and obligations based on an auction among qualified bidders. Thus for example if each of n bidders for a concession service demands C_i for $i = 1, \ldots, n$ we may award it to the bidder k with the lowest bid $C_k = \min_i C_i$ and compensate him

$$R_k = \min_{i \neq k} C_i$$

The regime conserves the simplicity of the fixed-price regimes, but limits the informational rent. It also offers perfect adjustment to heterogeneity, since prices may vary across franchises.

2.42 Further discussions on franchise auctions for electricity distribution systems can be found in NEMESYS (2005b). However, the problems are for limited markets with high concentration that bidding may be collusive, that excessive informational profits may be extracted and that competition may be hampered by asymmetric information among incumbents and entrants. Due to the current oligopolistic structure of the incumbent electricity distribution industry, the franchising instrument is likely to be used sparingly in Europe in the near future unless subject to more advanced designs

Technical norm models

2.43 At large, three kinds of regulatory production functions may be distinguished with respect to information requirement and potential application: statistical, benchmarking and (technical) normative models. In Figure 2-5 a production space and the underlying (unknown) production frontier is depicted with the results from the three model types. The benchmarking model elicits the information directly from the assessed data and makes minimal extrapolation from the data to form the "best practice" frontier. However, unless the industry shows some examples of best practice, this frontier is likely to be strictly inside the true frontier. A statistical frontier (such as an average cost function) also extracts information solely from the observations, but adds the assumption that good performance is as random as poor performance. If there is any variation in the sample, this frontier will be strictly dominated by the benchmarking frontier, except for simplistic models that add a restrictive structure to the function (linear with ordinary least squares regression). Note, however, that the true frontier in the case where the measured performance is stochastic is inside the frontier benchmarking model, closer to the statistical model. This implies that deterministic frontier models, such as minimal KPIs or DEA, applied to stochastic data would pick up "most lucky practice" rather than best practice.

2.44 The technical normative model, finally, is based on an attempt to come closer to the true production frontier, or to draw on other information than merely the observations. The concept is tempting in regulation because if its potential profit reduction possibility and its integration in yardstick regulation. However, given the high cost of failure and service interruption in network services, the issue of feasibility in the normative estimation is primordial. In Figure 2-5 this is indicated by a zone where the normative model (being a simplification of reality) actually dominates the true frontier, i.e., predicts a lower cost than feasible in reality using best practice.

2.45

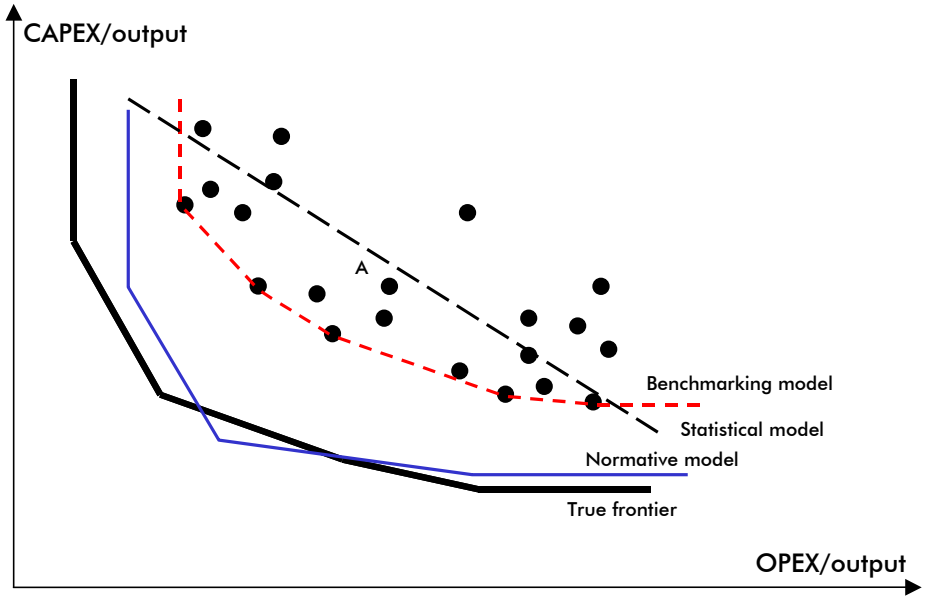

Figure 2-5 Production space and normative, statistical and benchmarking models.

2.46 In general, technical normative models are just special cases of engineering cost functions with varying level of information requirements. As such, they are used to prescribe rather than predict the optimal, or allowable, cost for a certain level of operation. Thus, the model's estimate can be made feasible by *parameterization* and *construction*.

2.47 *Conservative parameterization*. One approach to achieve feasible cost estimates is to tune parameters and variables in the model unilaterally in more conservative direction. In case of doubt, capacities, times and lengths are rounded upwards, risks are exaggerated and costs overestimated. The resulting error is always positive for the regulated firm and can be seen as the cost of information imperfection in the model. The risk of system error is born by the regulator, since this maximizes the social welfare.

2.48 *Construction*. To assure feasibility with a minimum loss of cost efficiency, norm values may be deducted from a realization of a network in all detail. Less likely to result in a mathematical model, this approach requires considerable effort and industrial expertise. If the technical system can be fully parameterized, an exhaustive frontier may be construction, even for networks that have never existed. If the analysis is made on discrete examples, perhaps candidates for improvement, some assumption is necessary to form the frontier (if necessary).

2.49 In DSO regulation, only two countries use formalized technical normative models, Sweden and Spain, cf. Agrell and Bogetoft (2003b). The Swedish Network Performance Assessment Model (NPAM) is an interesting example of model development that started using a fairly rough technical construction principle using *ad hoc* cost functions (Larsson, 1998) later to develop into a detailed conservative parameterization on the same schematic basemodel (Swedish Energy Agency, 2004). From an information viewpoint, the technical norm models are dubious instruments for regulation. First, the regulator is normally less informed about best practice, costs and standards than the firms. At best, this only implies high administrative costs for the development and operation of the model (five years of

work in Sweden for the model development, 12 M€ for GIS work in Spain). At worst, it may give rise to infeasibilities of the kind illustrated in Figure 2-5. Second, the technical models are inherently input-oriented, in spite of attempts to present them otherwise. The engineering cost function is an (imperfect) attempt to create a comparable asset base of an efficient firm. Third, technical models suffer from the problem of perfect hindsight planning, meaning that the calculated cost represents (at best) the cost of an instantaneous construction of a network for the current clients, as if they were to remain forever. However, under universal service obligations, networks are constructed sequentially for the connecting clients that have very limited commitments against the operator. Thus, the snapshot logic of even a perfect technical norm model may in fact not be the least-cost policy for construction and operation of a real network. Finally, the positive incentive effects of the technical norm models come incidentally from the yardstick regime in which they are inserted, not from the model in itself. Consequently, we argue that the information necessary to operate a yardstick model can be elicited, processed and interpreted in a theoretically more sound and practically less risky way using other models.

Hybrid mechanisms

2.50 Before closing the discussion of these schemes to regulate the overall compensation, we emphasize that most regulatory systems involve a mixture of many elements - just like there are many ways to coordinate activities in an organization. To balance the effects of information distribution and availability, risk and market structure, regulatory systems are the results of compromises between multiple socioeconomic objectives.

Regulation of public utilities and cooperatives

2.51 Before proceeding to an evaluation of the regimes previously presented, we will address the principal question on why and how to regulate firms that are owned by the consumers, either through municipal or cooperative ownership. Many presentations of regulation mechanisms address the problems conjectured or detected using arguments valid only for private profit-maximizing firms. However, since the prevalence of public firms among the Nordic DSO still is high, on the one hand, and their behavior may vary under certain regulation regimes, on the other hand, we need some more discussion on this issue, both here and in Chapter 7 from a practical viewpoint.

Theory on non-profit utilities

2.52 In the first case, theory tells us that the voting ratepayers would try to capture the firm as to minimize their own short-term tariffs through allowing low profits and potential price discrimination of non-voting ratepayers (public, commercial and industrial clients). Alternatively, capture is attempted by politicians that try to gain votes by lowering direct and visible expenditures for their voters. Another hypothesis with some empirical evidence is that political principals use utilities for public financing when subject to financing constraints on taxation from voters or state. The intentions to capture are neutralized by lack of effective information and management structures (elected board members have no insight and are not accountable to anybody, may be captured themselves by the firm) and the bargaining power of the firms' staff. Since they cannot increase the direct salaries

that are observable and comparable, the firm staff would in theory maximize the "good life" on the job, i.e. non-monetary benefits such as shorter working time, better working conditions, equipment and staff development etc. Altogether, the public firm would then be predicted to exhibit chronic inefficiency with respect to both cost and potentially even tariffs.

2.53 In the second cooperative case, the ratepayers are direct owners and may exercise more influence over the firm, including its tariff and investment policy. Theory predicts a similar behavior as above, managerial inefficiency due to lack of incentives and risks of opportunistic policies with respect to debt/equity financing and long-term investments. If the cooperative owners can sell their individual shares, the behavior of the firm will approximate a private firm. If the shares are non-transferable, all benefits have to be collected during the relationship, which creates disincentives for long-term investments and equity financing.

Critique

2.54 More recent work on non-profit firms (Gertler and Kuan, 2004) have refuted the hypothesis of chronic inefficiency, using empirical data from hospitals. To explain the finding, Glaeser (2002) presents a model for several service sectors where the firm indeed is captured its "elite" managers, blocking the public from direct influence. The firm's behavior approaches that of a producer-owned cooperative. However, rather than opting for an easy life, the managers may pursue efficiency under some conditions, whereof the most important is the presence of outside competition, such as in the hospital case.

Why regulate public firms?

2.55 A neoclassical motivation for regulation of public firms is based on the cost inefficiency, meaning that society would increase welfare by allocating a minimal amount of its scarce resources to each activity, irrespective of governance policy. Although the principals may choose to pursue other objectives (local employment, cross-subsidies to other activities, campaigning, etc), the principle says that the ratepayer, if given a choice, would prefer to pay an overall lower sum of taxes *and* tariffs. Another argument may be based on information asymmetry between the ratepayers and their elected representatives on the board of the utilities. There may be a willingness to pay extra for some non-monetary common benefits (environment, safety), but perhaps not at the actual cost. Specifying the operating cost in an efficient (competitive) and non-competitive part facilitates the evaluation by the rate payers of the value that their money provides.

How to regulate?

2.56 In the selection of instruments, it would be a logical flaw to assume that a simple high powered regime (such as CPI-X) applied to non-profit maximizing firms automatically could provoke an efficient response. Two problems may occur: In the first case the public firm has a soft budget constraint and can continue to operate at its current cost level irrespective of adjustments in revenue, e.g. by direct or equity-based political subsidies. In the latter case, a cooperative with effective management with an increased revenue cap will consequently not use it, since it is minimizing (short-term) tariffs, not shareholder value. In both cases, the price-cap instrument fails.

2.57 However, a more advanced theory picks up the argument by Glaeser (2002), where the efficient operation of the non-profit firm is caused by competition effects, not direct price regulation. In our context this would suggest that the non-profit firm would react to the *competitive information* in itself, being an observable indication of the management capacity. Instruments based on comparative and dynamic information would then be more likely to promote efficiency than equally high-powered regimes that are based on negotiated, arbitrary or historic prices or costs. Our challenge here is then to find an instrument, or a class of instruments, that could meet this condition and still maintain the desired properties for profit-maximizing firms.

Evaluation

2.58 In the NEMESYS (2005b), a systematic approach for the selection and evaluation of regulation regimes is derived from the theory and practice of contracting and regulation. Here, we abridge the discussion by resuming the most important criteria and subjecting the classical schemes to a qualitative evaluation.

Criteria

2.59 A mechanism (cf. 2.15) therefore coordinate the action of independent individuals, ensure that individuals have private motives to implement their part of coordinated plan, and ensure that coordination and motivation is accomplished at least possible transaction cost. To create a more detailed set of criteria, we organize the criteria from 1.04 above into the three headings as in Table 2-1 below, with some minor rewording of the former. The criteria are not ordered in importance and cannot claim to be exhaustive, but provide a good indication for the purposes of this comparison.

Table 2-1 Regulatory objectives

Optimal allocation of decisions and information
Incentives for sound industry structural changes
Incentives for efficiency improvements
Incentives for tariff reductions
Incentives for customer oriented quality improvements
Incentives for (re)investments
Long-term regulatory credibility
Unbiased firm-level performance assessment
Low administrative costs of regulation

Alternatives

2.60 As a basis of discussion, we now expose the classic mechanisms in 2.29 to a qualitative evaluation using the criteria above. Naturally, the evaluation is only indicative as no specific instances of the regimes are specified, neither are any hybrid regimes evaluated. The objective of the exercise is merely to motivate a further choice of focus into a specific orientation.

2.61 In particular, we consider the following examples of regimes:

1) *Cost-recovery*. A rate-of-return, cost-oriented regime such as widely present in USA and earlier in e.g. Finland and Norway. Firms are authorized to a predetermined capital cost on pre-approved investments in addition to direct by-pass of certain operating costs.
2) *Price cap*. A regime of the anglo-saxon CPI-X type where the regulator determines ex ante a fixed reduction (X) of some base-level price or revenue. In practice, the regulatory asset base is approved by the regulator, that also decides on the return for investments in the period. At the end of some periods, the base is reset to current cost.
3) *Yardstick regime*. A regime in which costs or revenues are set in competitively across comparable firms by using averages, best practice or a frontier model. Allowable revenues next period depend on performance the previous period.
4) *Franchise auctions*. Firms are awarded concessions based on tender auctions formulated in tariff level using a pre-defined task specification. The concessions are defined on time periods between 5-15 years and then resubmitted.
5) *Technical norms*. The allowable revenues for the firms are determined using an engineering cost model developed by the regulator. The model presumes a complete task description, including quality provision and technical development.

Table 2-2 Evaluation of regimes with respect to regulatory objectives

Concern	Cost-recovery	Price/revenue caps	Yardstick regimes	Franchise auctions	Technical norms
Optimal allocation of decisions and information	-	-	+	+	-
Incentives for sound industry structural changes	--	+	+	+	-
Incentives for efficiency improvements	--	0	+	+	+
Incentives for tariff reductions	--	0	+	++	-
Incentives for customer oriented quality improvements	+	-	?	-	-
Incentives for (re)investments	+	?	?	++	-
Long-term regulatory credibility	0	0	+	0	-
Unbiased DSO performance assessment	+	+	+	?	?
Low administrative costs of regulation	-	0	0	-	-

Analysis

2.62 *Sector structure*. The coordination dimension favors regimes that are high-powered and independent of organizational form, such as the price caps and auctions. Cost recovery models provide disincentives to restructuring by guaranteeing return irrespective of performance. Technical norm models give disincentives for restructuring of old networks, since the new norm, determined on green-field basis for the merged entity, may be largely below the actual costs.

2.63 *Decision making*. The decision rights are allocated to the most informed party in the high-powered regimes, in particular in the franchise auction model where potentially even the concession area and the service could be renegotiated at renewal. Revenue caps, as opposed to price caps, will normally require some review of investments or output to balk skimping on quality or price discrimination. Technical norm models may require an extensive information exchange of fairly detailed technical information that cannot be optimally processed by the regulator. In practice, the least delegated decision rights are found in cost-recovery regimes, where the regulator must monitor investments as well as operating costs to detect imprudent expenditure.

2.64 *Efficiency incentives*. The most extreme regime, cost-plus, gives direct disincentives to improve operating efficiency. Rate of return regimes show the classical Averch-Johnson (1962) investment distortion, leading to gold plating. Yardsticks and auctions provide strong efficiency incentives since their revenues are completely exogenous and set long-term, respectively. CPI-X regimes suffer from end-of-period phenomena, where all efficiency incentives are exhausted at the beginning of the period and costs are inflated, like a floating device, at the end of the period to start the next period at a high level.

2.65 *Tariff reduction incentives*. Revenue caps provoke tariff adjustments in relation to actual and predicted volume. Increased volume suggests tariff reductions, but decreases in volume actually promoted tariff increases. Yardsticks can provide incentives for tariff reductions if they are defined on tariffs, else by the mechanism of allowed revenue as any high-powered regime. The most effective mechanism for tariff reductions is the franchise auction, that can be compared to a tender for service rights.

2.66 *Quality improvement incentives*. Due to generous reimbursements of capital costs without risk, the cost-recovery regimes promote any investments that lead to budget expansions, among those quality increases. The opposite is true for high-powered regimes such as price-caps. To work, the regulator in such a regime must have completely defined all dimensions of the service before fixing its price. Even so, such a regime provides no gains from unilateral improvement of quality during a period. Rather, such improvements would lower the firm profit without increasing any future value. The auction design may promote quality incentives at renewal if such are taken into account in the tender, but standard concession contracts suffer from the price-cap problem. Technical or economic yardstick regimes focused at price exhibit the same problems since quality dimensions are difficult to integrate into a comprehensive metric (cf. Chapter 4). However, the shorter review period makes dynamic yardstick mechanisms easier to adjust to varying quality levels.

2.67 *Investment incentives*. The cost-recovery regimes promote investments and possibly over-investments due to the Avec-Johnson effect. The high-powered regimes on the other hand may lead to under-investments. Of course, this will depend a lot on the parameters used in the actual regimes, but Kirkpatrick et al. (2004) suggest that 53% of the countries under rate-of-return regulation report overinvestment and 42% of the countries operating price-caps report underinvestment problems. It is somewhat surprising for regulators to discover that high profits in revenue or price-cap regimes do not lead to investments, due to regulatory uncertainty. Estache et al. (2003) found that price-caps increased the cost of capital and thus discouraged investments. Long contracts type concession franchises provide the best incentives for cost reducing investments during the period, less at the end.

Yardstick regimes with capped profits are likely to carry high risk premiums, uncapped profits with robust models are associated with lower risks and likely to encourage investments for efficient firms.

2.68 *Regulatory long-term credibility*. Cost-recovery approaches are, in spite of their obvious drawbacks, relatively credible for weak regulators. An uninformed regulator with low budget faces high political risks when launching a CPI-X regulation on weak information and may prefer a less visible cost-inefficiency rather than fat cats. Frequent reviews and in-period claw-back of wind-fall profits under revenue caps lower the credibility, which makes the approach difficult unless based on some econometric model. Concession auctions are demanding to organize and the results may be unpredictable in soft markets, there is a high risk of collusion if the design is poor. This reduces the credibility of the instrument and thus its effectiveness. Technical yardsticks share the same problem, the inherent difficulty to maintain a valid engineering specification under potentially changing technology threatens the credibility, as does the judicial risk of ending up in technical court appeals with uncertain outcomes. Although less used, dynamic yardstick regimes are here the safest choice if they are transparent. Frequent settlements and endogenous capital costs relieve the regulator of the asymmetric information problem involved in forecasting the sector development.

2.69 *Unbiased performance assessment*. The simple cost recovery mechanisms are usually perceived as 'fair' and 'transparent', giving all firms equal opportunities. Concession auctions, on the other side, may in practice give advantages to larger firms that have the resources to successfully engage in the complex and costly bidding process. The neutrality for the other regimes primarily depends on the underlying performance assessment model(s). Here there is a tradeoff between transparency, simplicity and neutrality. An average cost yardstick with annual updating (like in the Netherlands) can be perceived as intuitively attractive for all parties, but if the production function is more complex and involves location- and product-mix dependent costs, the regime is not neutral. Frontier models as DEA give conservative estimates that are neutral under constant returns to scale assumptions.

2.70 *Administrative cost of regulation*. Input-oriented approaches, such as cost-plus and technical norms, require heavy processing of information to determine performance and tariffs. In the USA, rate-of-return regulators determine details down to the admissible hotels on travel reimbursements to track 'imprudent expenditure'. As mentioned, franchise auctions may incur high, but very infrequent, costs when they are renewed. For the firms, all model-based approaches involve some regular reporting, that could be automated if output-based.

Transparent regulation

2.71 The regulation must take account for the parties' bounded rationality, see Hart (1995) for a discussion of bounded rationality and the implications for contract design. The parties act according to perceived incentives, which may differ from the actual incentives. Therefore it is important to use simple systems, so that the parties can easily relate their choice of action to the compensation scheme set out in the regulation. However, simple systems may also mean less complete contracts, where more questions are left unanswered in the contract.

2.72 In order to affect the behavior of the parties the incentives should be articulated ex ante. There is no motivational effect from an unexpected bonus. This may favor ex ante regulation. On the other hand, if the environment is uncertain such that the companies cannot foresee with good precision the impact and payments resulting from given actions, this does not contribute to incentive provision and an ex post regime with sequential updating may be superior.

Conclusion

2.73 From the evaluation above, we see that the yardstick regimes stand out as credible alternatives. On the one hand, they bridge the information gap between the regulator and the firm, in that they form a 'pseudo'-market for the firms. This allows the regulator to concentrate its efforts to areas where it is necessary and relevant, such as monitoring of terms, industry structure and quality development. On the other hand, they offer a credible alternative in that they minimize the risks for in-period opportunism by the regulators and the firms.

2.74 In the following chapter, we will focus on the yardstick mechanisms, while keeping in mind the two caveats that surface from the evaluation above: (i) quality regulation must be handled in a robust and transparent way to promote investments. (ii) the basis of comparison for the yardstick model must be well selected as to avoid problems related to asset age, investment cycle, ownership and demand structure.

3. Yardstick Frontier Competition

3.01 In this section, we examining the yardstick mechanism from a theoretical and applied perspective, including references to recent work in frontier analysis.

Yardsticks revisited

3.02 The yardstick competition idea first introduced by Shleifer (1985) is an interesting addition to the regulatory arsenal. Under yardstick competition the performance of a regulated firm is compared to the performance of a reference group. Ideally, the reference group shall be subject to the same (or harder) conditions and provide at least the same services. The idea of the yardstick principle is now that the evaluated firm must perform as well as the reference group. In a yardstick regime then the allowed or compensated costs will be set by the cost levels of the related benchmark firms. This mimics a competitive system where a firm cannot survive if it charges more than it competitors, the reference group.

3.03 Applying the yardstick idea to the regulation of distribution companies involves setting an individual cost target for each distributor that equals the realized cost by other (comparable) agents in the same period. If the residual profit is retained by the distributor, and if all distributors produce the same product under the same conditions, the yardstick competition provides an optimal incentive mechanism that solves many of the problems of a CPI-X regime. In particular, it eliminates the fear of setting the expected productivity (technological progress) X to high and hereby generating unfair bankruptcies. Likewise, it eliminates the fear of predicting a too low productivity development X and hereby leaving the firms with excessive profits (rents). Also, the endogenous determination of the cost norm solves the problem of setting (arbitrary) compensations for changes in the service profiles.

3.04 In the implementation of yardstick regimes, part of the challenge is to develop reasonable reference groups and to calculate their comparable costs. Using modern benchmarking techniques, the two tasks will usually be handled simultaneously. Frontier methods like Data Envelopment Analysis and Stochastic Frontier Analysis can – for example - be used to define endogenous reference groups and associated costs levels. Therefore, the introduction of a yardstick regime does not reduce the need for benchmarking as it is known from CPI-X regulation.

3.05 In applied work and regulatory proceedings, the terminology yardstick competition is sometimes used for regimes of the CPI-X type. The logic seems to be that the reference group sets a yardstick against which the evaluated firm shall compete. Theoretically, however, it is customary and important to distinguish between an ex ante CPI-X regime and an ex post yardstick regime. In a stochastic environment, this is an important distinction as explained above.

3.06 We might add that actual CPI-X regimes typically do have some ex post elements as well. It is common for example to make ex post adjustments to account for inflation and volume variations. Moreover, in practical yardstick regimes it will often be necessary to make some delays in the adjustments of the yardstick. Indeed, in our specific proposal for a revenue yardstick model below, we shall

introduce a two year delay to ease the practical implementation. With such delays, the yardstick regime resembles a CPI-X regime with a more frequent updating of the cost norms – and a rather fast catch-up requirement.

Yardstick competition in electricity regulation

3.07 Pfeifenberger and Tye (1995) discuss various ways of introducing yardstick competition in the regulation of utilities. Yardstick competition can be used both to achieve measures of efficient cost levels and to adjust for output characteristics under rate of return regulation. For example, Mississippi Power established an incentive mechanism that adjusts its rate of return based on utility's performance compared to price, customer satisfaction and reliability of several utilities in the region. Massachusetts Electric proposed a mechanism that would judge the utility against a set of benchmarks: costs per kWh; number of customers per employee; conservation achievements; service reliability; employee wage and salaries; customer satisfaction; safety and environmental performance; and asset utilization.

3.08 Resende (2002) discusses the potentials and difficulties associated with implementing yardstick competition in price cap regulation of Brazilian electric distribution. The industry is very heterogeneous due to very large regional differences. Large investments are required to reduce congestion. The Brazilian regulation is based on price cap regulation (CPI-X) with periodical (5 year) reviews. The purpose of the periodical review is firstly to provide a fair rate of return enabling the firms to attract capital for investments. Secondly, historical productivity data is used to update the X factor. Resende (2002) propose a new regulatory procedure, where relative efficiency scores are used to guide appropriate determination of the productivity offset X. He proposes to use DEA analysis and (i) identify efficient firms and (ii) calculate total productivity growth used to determine the X factor.

3.09 The use of DEA and yardstick elements has also been investigated in connection with the revision of the Dutch regulation, c.f. Dte(2002). A simple yardstick regulation based on average costs is now part of the incumbent regulation. The simplicity of the Dutch yardstick model reflects both the fact that only few DSOs operate in Holland and that they have quite homogenous working conditions.

3.10 Likewise, the proposed regulation for Norwegian DSO to be implemented in 2007 includes clear yardstick elements. The yardstick costs will be set using a DEA model, most likely along the lines of the model used in the last regulatory period with some improvements. Also, the new proposal involves a time lag between cost realizations and yardstick setting, cf. Norwegian Water Resources and Energy Directorate (2005)

DEA based yardstick competition

3.11 The main problem of the basic yardstick model is the comparability between agents and in particular its inability to accommodate variations in the output profiles and operating conditions between the agents.

3.12 The key to effective regulation is found in the access to information. In a series of papers, we have therefore proposed (a dynamic) extension of the yardstick

competition model using DEA. By utilizing the maximum amount of information in a rich production model and by reducing the regulatory lag, five positive effects are obtained. First, by tailoring the revenue cap to the individual agent in a close sense, the total informational rent, i.e. the extra profits earned from private information, is minimized. Second, by reducing the time lag from evaluation to reimbursement and repeating the evaluation more frequently, the risk and the consequences of misrepresenting an agent in a yardstick sense are minimized. Third, by excluding the evaluated unit from the basis of comparison, the ratchet effect can be effectively dealt with. Fourth, by using observed production cost rather the estimated consumer prices, the arbitrariness of the CPI may be avoided. Similarly, the need of postulating a negotiated X factor may be substituted by an actually realized productivity improvement. Finally, by using the richer production description in DEA, changes in production profile can easily be taken into account.

Static Incentives with Adverse Selection

3.13 Bogetoft(1997, 2000) considers a regulation setting with combined adverse selection and moral hazard elements and

1) Considerable asymmetric information about the technology
2) Risk neutral firms
3) Firms seeking to maximizes both profit and organization slack, {Profit + ρ•Slack}, where slack is the difference between actual costs and the minimal costs necessary to produce a given output.

3.14 The firms are supposed to have superior technological information. In the extreme case, they know the underlying true cost function with certainty while the regulator only knows the general nature of the cost function. Thus for example, the regulator may know that there are fixed unit costs of the different outputs but not the exact unit cost, being the firms' private information. Alternative assumptions may be made about the information available to the regulator. We may assume for example that he knows simply that the cost function is increasing and convex.

3.15 The optimal solution in this case depends on whether the actual cost can or cannot be verified and hence contracted upon. I.e., can the regulator observe and contract upon a specific cost, or is the vertical separation so incomplete that reported costs are meaningless?

3.16 If the actual costs cannot be contracted upon, the *optimal* solution is to use the following *revenue cap with so-called non-verifiable cost information*

$$R^i = k + C^{DEA\text{-}i}(y^i)$$

where R^i is the optimal reimbursement to firm i, k is a lump sum payment and $C^{DEA\text{-}i}(y^i)$ is the DEA-estimated cost norm based on the other firms

3.17 The size of the lump sum payment depends on the firm's alternatives, including his profit potentials in other markets or the surplus from contracting with other regulators, say private insurance companies.

3.18 If instead we assume that the actual costs of the firm can be contracted upon, the *optimal reimbursement with so-called verifiable costs* becomes

$$R^i = k + c^i + \rho \bullet (C^{DEA\text{-}i}(y^i) - c^i)$$

That is , the optimal reimbursement to Firm i equals a lump sum payment + actual costs + a fraction ρ of DEA-estimated cost savings.

3.19 The structure of this payment schemes can be interpreted as a *DEA based yardstick model*: Using the performance of the other firms, the regulator creates a cost yardstick and the regulated firm is allowed to keep a fraction ρ of his saving compared to the yardstick costs as his effective compensation. Figure 3-1 illustrates this reimbursement scheme.

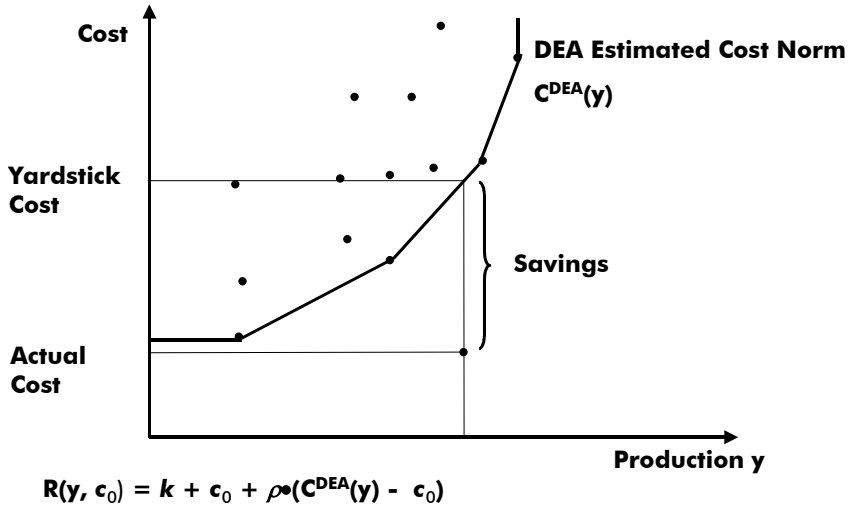

Figure 3-1 The DEA yardstick model in the cost – production space

3.20 These results provides an incentive rationale for using DEA based revenue cap systems in contexts where the regulator face considerable uncertainty about the underlying cost structure.

3.21 Several extensions and generalizations of these results are provided in Bogetoft (1997, 2000). In particular, it is shown how the structure of the schemes are essentially unaffected by introducing decentralized decision making (where the firms decide on the output mix) as well as participatory budgeting arrangements. Also, the impact of introducing genuine social benefit functions, alternative costs of slack reduction models, rationing etc is investigated.

3.22 To understand the background and logic of the above DEA-based yardstick schemes, it is crucial to understand the role of rho and the nature of slack.

Slack and rho

3.23 In principle, slack is the usage of resources above the minimal necessary level and rho, ρ, is a parameter measuring the relative value of slack compared to profit. We typically assumes that ρ is less than one, i.e. that slack is less valuable than profit.

3.24 A firm may expend excess resources because it is technically or allocatively inefficient i.e. because it do not use the best possible procedures or the cheapest combination of production factors given the present factor prices. A standard assumption in economic theory is that firms seek to maximize profit and since slack implies a reduction in profits, they seek to minimize slack. In practice, however, this assumption may not hold which is why we include slack in the general objective function. They are at least two reasons why firms may like slack.

3.25 Firstly, it may be rational for profit maximizing firms to operate with some slack – or at least to model the firm as if it chooses to work with some slack simply because the modeling of the different firm processes can hereby be simplified. To illustrate this, one may observe that there are learning and motivation costs associated with the elimination of slack – and that these costs may at the margin exceed the costs of slack. Likewise, there may be benefits of having some slack in a firm since it may provide a buffer against unforeseen future events, be a means of R & D that may improve profits in the long run, or be a way to compensate the employees, e.g. with fringe benefits. For a formal and more in depth treatment of such *rational inefficiencies*, see Bogetoft and Hougaard(2003).

3.26 Secondly, some firms have other objectives than profit maximization. In a (user-owned) cooperative, for example, the official objective is not to maximize profit but to maximize surplus to the user. Profits should in principle be distributed to the cooperative members via low output (or high input) prices meaning that profits will tend to be low or absent. In a municipality owned firm, supplementary objectives could be also to increase employment or solve other societal problems.

3.27 Whatever the motivation for having slack, we will still argue that the rho factor should be less than or equal to 1. The reason is that profit is a surplus that is more flexible that slack. Since profit is a surplus that can be used both in and outside the firm, both on and off the job, it is more valuable than slack which are excess resources in the firm only.

Incentive power and rho

3.28 In the incentive schemes, the rho ρ pops up as an incentive power parameter. It shows how much of an estimated saving the firm can keep – and how much of possible excess costs it has to cover itself via a below average return on assets.

3.29 To illustrate, if the yardstick costs of comparable firms are 100 and the actual costs of the firm is 80, the firm will be compensated with $80+\rho(100-80)$ such that it effectively gets an (excess) profit of 20ρ. Similarly, if its actual costs are 120, it will be compensated with $120+\rho(100-120)$, i.e. with $120-20\rho$, such that it will in effect lose 20ρ compared to having a normal profit level. Figure 3-2 and Figure 3-3 below illustrate this.

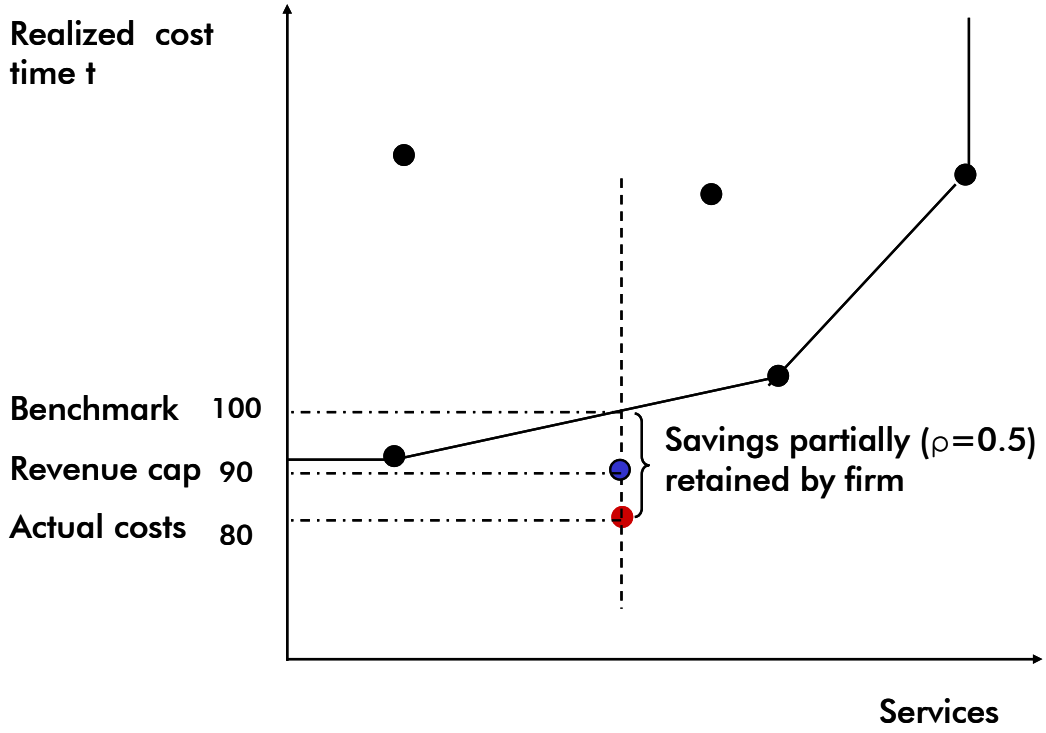

Figure 3-2 DEA based yardstick with extra saving

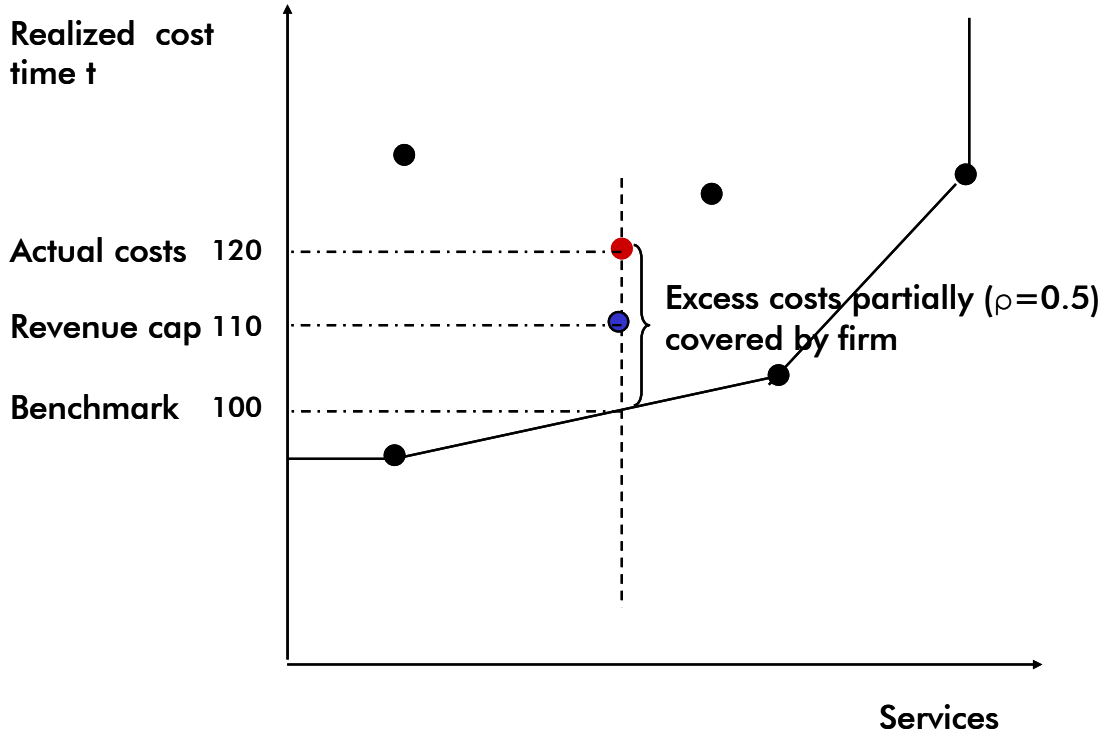

Figure 3-3 DEA based yardstick with extra costs

Verifiability of costs

3.30 The incentive schemes involving rho presume that cost measures are available and that they can be verified to a third party. In practice, this is not always the case. In fact, one of the real challenges in regulation is to construct the comparable cost measures. Regulatory agencies around the world spend considerable resources trying to construct such measures.

3.31 The single most challenging problem here is the cost of capital problem. It is theoretically complex to allocate capital costs over the usage period of the different assets and even ignoring this principal problem, there are considerable humanizations problems when it comes to creating at least comparable numbers. First of all, depreciation policies may differ depending on the tax regime and the strategies of the firms. Secondly, different access to the capital markets may make the interest rates differ depending on the ownership structure. A municipality owned utility, for example, may have seemingly cheaper access to capital because it can borrow from the tax payers or because it can use the tax basis as "collateral" in the dept financing. We will return to these problems in chapter 8. The examples above suffices to illustrate that verifiable, correct and comparable costs measures are often not available.

3.32 In such cases, one cannot easily distinguish between slack and profits and the regulator is forced to forgo the slack trading involved in the standard rho incentive scheme. To illustrate, consider the above examples and assume that $\rho=½$. Now, if the firm has a minimal costs of 80 and the yardstick calculated from the reports of others are 100, its allowed revenue is $80+½(100-80) = 90$. However, if it can simply claim that it has costs 120 instead without the regulator being able to check the cost reporting, it will instead get a revenue of $120+½(100-120) =110$.

3.33 Hence, the rho scheme will not work with non-verifiable costs. Firms will have strict incentive to boost costs sine any claimed cost increase generates a higher income. As proved in Bogetoft (2000), the best one can do in this case is to basically treat slack and true costs equally, i.e. set $\rho=1$, and simply compensate the firms their yardstick costs. In the above example, the firm will be compensated with 100 undependably of its own cost report, cf. also Figure 3-2 and Figure 3-3.

Dynamic Incentives with Ratchet and Limited Catch Up

3.34 In Agrell, Bogetoft and Tind (2002, 2005) the scheme above is extended by introducing a time dimension. The dynamic perspective gives rise to new issues, including

1) The possibility to accumulate and use new information
2) The need to avoid the ratchet effect, i.e. deliberate sub-performance in early periods to avoid facing too tough standards in the future
3) The possibility of technical progress (or regress)

3.35 Nevertheless, the structure of the optimal dynamic scheme is similar to the ones developed above. Thus the optimal revenue cap for a firm is found by a DEA based yardstick norm. The best scheme assuming verifiable information and taking into account the generation of new information, the ratchet effect and the possible technical progress, i.e. the so-called *optimal dynamic reimbursement with so-called verifiable costs,* becomes

$$R^i = k + c_t^i + \rho \bullet (C^{DEA\text{-}i}{}_{1\text{-}t} (y_t^i) - c_t^i)$$

That is, the optimal reimbursement to firm *i* in period *t* equals =lump sum payment + actual costs in period *t* +fraction ρ of DEA-estimated cost savings in period *t* using all the information from the other firms generated in periods 1 through *t*.

3.36 The optimality of the above scheme primarily relies on the assumptions of risk neutrality and considerable asymmetric information about the costs. The DEA yardstick is optimal by limiting the information rents from asymmetric information, by providing cost reduction incentives and by avoiding the risk of bankruptcy.

Limited Catch Up

3.37 In Agrell, Bogetoft and Tind (2002, 2005) the schemes above are modified to take into account also the

1) Possibly limited catch-up capacity, i.e. the fact that it may take time for a DMU to learn the best practice
2) Possible cost of innovation (frontier movements) and loss from dissemination (sharing) of information

3.38 It is interesting to observe that if we take the DEA based yardstick scheme, that can be shown to be optimal under the assumptions outlined above, and if we introduce a further assumption about limited catch-up capacities, we get a scheme with some resemblance to the core of the present Norwegian mechanism. Indeed, if we further assume a single dimensional output, constant return to scale, fixed relative factor prices, a constant exogenous frontier shift, and no difference between profit and slack value, ρ=1, we get the Norwegian scheme as a special case.

Risk and risk sharing

3.39 An immediate impact of the dynamic yardstick scheme is that the allowed revenue to a company tracks actual productive development rather than the expected development over for example a 5-year period.

3.40 The fact that the revenue cap cannot be foreseen and that it depends on the performance of others is a popular objection to yardstick schemes. Some consultants and companies seem to believe that this imposes excessive risk on the firms. Or even worse, it makes the correspondence between firm behavior and firm gains more random and hereby tends to reduce the incentives for cost minimization. It is important to emphasize therefore, that this is not the case. Relative performance evaluation is done precisely to allow a more precise interference of behavior. The idea is that by looking at the performance of others,

we can filter out the general sector shock that the firms cannot control and hereby make a more precise linkage of payment to behavior. In other words, (appropriately designed) relative performance evaluation it actually eliminating (reducing) the arbitrariness of the payment rather than causing (exaggerating) it.

3.41 Intuitively, the advantage of the yardstick scheme is that it adapts the requirements on the firm to the development in the environment. It is not particularly fair (efficiency improving, risk reducing) to face constant payment plans when the operating conditions change. This is widely accepted when it comes to changes in economy wide prices etc – and the yardstick idea is precisely to make more of similar adjustments to ensure that a firm does not suffer or gain from non-controllable conditions.

3.42 A further advantage of the yardstick scheme is to ensure a more direct linkage of consumer costs to underlying changes in distribution costs. This is advantageous by allowing better system wide decisions. The advantage of prices that reflect the underlying costs is that the users can better make optimal decisions, e.g. about the choice among alternative energy sources.

3.43 The optimality of the DEA based yardstick scheme is – as mentioned above – derived under the assumption of risk neutral parties. In reality, however, this may not be a valid assumption. The firms and/or consumers may be *risk averse*. Intuitively, the effect of the yardstick scheme is to make the prices paid by the consumers vary more. This may appear reasonable when the firms are risk averse and the consumers – by the limited budget share used on distribution costs for example – are risk neutral. On the other hand, if the consumers are risk averse and the firms – by their investors being able to diversify – are risk neutral, the yardstick scheme may appear flawed by imposing too much payment variation on consumers. Again, however, one must be careful. It is sub-optimal to make risk-sharing arrangement by making the behavioral inference less precise. This may make the payments more stable, but it comes at the cost of incentive provision and informational rents.

3.44 Risk aversion may call for alternative arrangement, e.g. *insurance arrangements* where the consumers – in addition to the distribution services – buy price guaranties from the companies. A possible practical arrangement could be that the consumers in a five year period pay according to a traditional CPI-X scheme but that the difference between their payment and the yardstick payment then is evaluated and distributed / taxed on to the consumers in the next five year period. This would be a relatively simple modification of the incumbent CPI-X scheme in many countries. Note also, that it is not necessarily optimal that the consumers pay according to a CPI-X scheme. They could pay according to many other schemes – and indeed it may be relevant to have different schemes that the consumers can choose from depending on their risk aversion and expectations about the future.

3.45 It is interesting to observe that the proposed scheme for the second regulatory period in Holland has some of these features although the yardstick model is a simplified version of the above, cf. Dte (2002).

Yardstick regulation and the benchmarking model

3.46 The theoretical results show that a DEA-based yardstick regime is the optimal regime under some assumptions. From a practical point of view, however, an important issue is how well the regulatory setting matches the ideal assumptions of the theoretical set-up. In case of deviations, the questions are how the model and results shall be modified.

3.47 We have already discussed some of the possible discrepancies between theory and practice above. In particular, we looked at risk aversion and non-verifiable costs and how this may call for modifications of the basic DEA based yardstick. We shall continue below by discussing also the difficulties of getting and processing the information in due time – and how this may call for further modifications.

3.48 Before proceeding, however, it is worthwhile to comment on the use of DEA as the underlying benchmarking techniques. This technique typically enjoys great popularity among researchers, consultants and regulators but it also leads to some fear among of too demanding conditions e.g. among DSOs.

3.49 The optimality of the DEA approach rests on the assumption of little a priori information about the cost structure. This makes it necessary to use a flexible and cautious benchmarking approach like DEA.

3.50 The optimality also invokes that the minimal cost level of the DEA model can be attained by any firm working sufficiently hard. This presumes that all firms are equally talented – or what may be easier to assume, that we simply do not accept that any deficiencies in the ability to undertake the DSO activities shall be costly to the consumers.

3.51 The theoretical results – or at least the most striking of these given explicit formula for the revenue caps - also presumes that there is no noise in the observations and that the chosen outputs in the benchmark analyses include all the relevant cost drivers. This assumption if of course not entirely realistic. Despite all efforts the data will contain noise and the benchmark model will not be entirely well specified. Combined with the use of a frontier estimation of the least costs necessary to deliver the specified services, this will tend to lead to some under-estimation of the true minimal costs. This underestimation is more or less fully compensated by the up-way bias in the costs estimates that results from having no firms with exactly the same conditions.

3.52 Still, there may be some risk of under-estimating the true costs for some firms. The importance of this risk will have to be tested and investigated as part of the benchmarking exercise using simulation, bootstrapping and similar techniques. What is important to emphasize at this stage, however, is that this problem does not invalidate the use of a frontier approach. The flexibility of the DEA based cost function for example has advantages even with noisy data.

3.53 If however the noise or specification problems suggest a significant downward bias in the cost estimate, it may be useful to modify the yardstick costs when setting the revenue cap. A pragmatic solution could be to include an *safety margin* by using for example 1.1 times the DEA estimated costs as the yardstick costs in the formula above.

3.54 The possible loss from such an adjustment is that the firms may end up earning higher rents. The efficiency and investment incentives however will not suffer. In this respect, the noise problem is mainly a distributional problem between the DSOs and the consumers.

Conclusion

3.55 To summarize, we see that the DEA based yardstick schemes solve many of the usual CPI-X problems, including risk of bankruptcy with too high X, risk of excessive rents with to low X, ratchet effect when updating X, arbitrariness of the CPI measure, arbitrariness of the X parameter, and inability to include changing output profiles.

3.56 The most important difference between a yardstick schemes and a more traditional CPI-X regime is that the firms are compared to actual cost frontiers rather than some a priori expected projected cost frontiers. This reduces the informational and analytical requirement put on the regulator and allows for a more precise inference of actual performance. It hereby also allows for a better incentives.

3.57 While some may intuitively see the lack a priori knowledge about allowed costs as an increased business risks, the risk is actually reduced. It is more risky to work with a fixed income and changing costs than to work with an income that more closely tracks the cost development.

3.58 Although the yardstick regimes outlined here have many advantages and offers a useful starting point for the design of regulation, several issue remains in an actual implementation. We have already discussed some of them, including the challenge of developing a good benchmarking model and ways to compensate for sub-optimal benchmarking by less "aggressive" regulation. We will address more problem in the following chapters. Most significantly we will address the problem of having time and resources to collect and process the necessary information in due time and the problem of evaluating the costs to begin with.

3.59 We have already touched briefly on the last problem above. The creation of comparable and verifiable cost measures is complicated not the least by the capital valuation problem that we discuss in more details in Chapter 8. It may therefore be worthwhile to settle with a scheme that is based on non-verifiable costs. The advantage of such a scheme is that it saves on the direct regulation costs. A possible disadvantage is that it leaves more rent to the firms. The proposal we develop in Chapter 5 takes a middle position. It is based on a cost measure that is simple to verify, namely the customers' total charges, but that do not allow us to distinguish between minimal costs and slack.

4. Quality regulation

4.01 Quality has traditionally been handled through the imposition of a system of compulsory and a system of suggestive minimum standards. Coupled with a tendency to rely on engineering reasoning, this has lead to relatively high quality standards in northern Europe. This however may neither be optimal nor the long run equilibrium. First, the cost of ensuring the present high quality level may exceed the benefits and the present quality level, although certainly high enough, may actually be too high and too costly. Second, any change in the regulatory approach will change the behavior of the agents. In particular, a movement towards a more high powered arms-length incentive regulation will induce the firms to focus more on cost minimization with a possible adverse effect on quality.

The basic quality problems

4.02 The basic underlying problem is to determine the optimal trade-off between the costs of producing higher quality and the benefits derived from it. This problem is illustrated in Figure 4-1 below. Here the cost function C(q) is the cost to the DSO of provided DSO services of different quality levels. The benefit function B(q) is similarly the gains to the consumers from different quality level. The optimal level leads to the largest difference between costs and benefits.

Information and strategic behavior

4.03 In reality the regulator knows neither costs nor benefits *a priori*. He must therefore try to reveal information about these aspects from the firms and the customers. This raises the problem of *asymmetric information and strategic behavior* since the firms may want to exaggerate costs to get a higher compensation and the customers may want to underplay their true values to pay less. Faced with these problems, the regulator should not strive for so-called *first-best* solutions as illustrated above. Rather, he must settle with second best solutions or – if he takes into account broader systems costs like administrative costs - third best solutions.

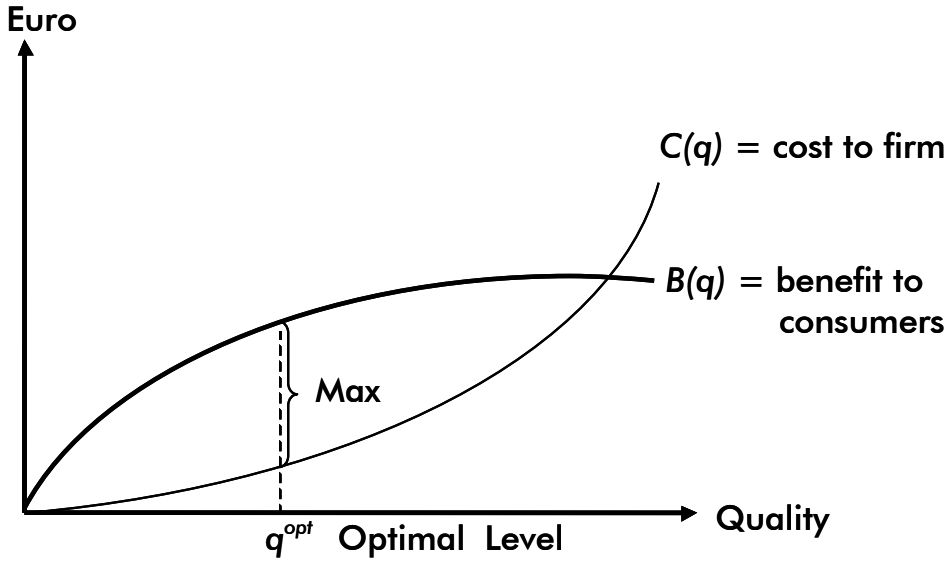

Figure 4-1 Optimal quality level

Regulatory phases

4.04 The tasks involved in solving this underlying problem in the context of asymmetric information and strategic information involves the following phases:

Determining the regulatory principles

Investigating the costs and benefit elements

Choosing a desired quality level - or a desired bundle of quality characteristics.

Implementing the desired qualities

4.05 We shall now discuss some important decisions to be made and some useful tools to support these phases. For an extended discussion, we refer the reader to the NEMESYS Sub-project B report.

Quality dimensions

4.06 Quality has several dimensions and different dimensions may call for different regulatory mechanism.

4.07 The quality of electricity distribution has traditionally been measured in three broad dimension:

1) Reliability of supply
2) Voltage quality
3) Commercial quality

Numerous indicators can be used to measure these quality dimensions. cf CEER(2001). Reliability are often summarized in terms of SAIFI (outages/year), CAIDI (min/outage) or simply as SAIDI (min/year). To capture voltage quality, focus has been given to indicators of frequency, voltage levels, voltage dips, temporary transient over-voltage, inharmonic voltages etc. To capture commercial

quality, a series of indicators including response to claims times, accuracy of bills, estimating charges, number of annual meter reading etc. have been used.

Verifiable and collective qualities

4.08 The quality indicators above are all relatively easy to measure and verify ex post. This eases the regulation of these properties since it eliminates (or reduces) the incentive problems involved in measuring compliance with standards and contracts ex post. Although it is possible to incentivize non-verifiable qualities – just like non-verifiable costs can be incentivize as discussed in the last chapter- we shall restrict the discussion below to such verifiable properties. The reason is that a sound system based on one of the many such measures available would in itself be a major step forward in most of the Nordic countries.

4.09 Likewise, and for the same reasons, we shall restrict attention to collective quality aspects here. In the *collective regime*, all customers receives the quality level – or at lest the same minimal level. The regulator works as a proxy customer and he imposes universal service obligations. In the *individual regime*, the regulator allows the users to demand and the firms to supply different qualities to different customer groups. The terms may be settled through bilateral negotiations among the firms and the customers. Since individualized adjustments are already in at least some of the cases where it is easy and sensible form a technical and economic sense, we shall not focus on such finer details here.

Comprehensive or partial regulation

4.10 A principal question facing the regulator is whether to integrate the quality dimension into the price regulation framework to form a comprehensive model of the costs of providing different levels of different qualities of output. Theoretically, this would be the ideal solution but practically, this may lead to dimensionality problems in the estimation of the resulting complex and detailed model. A more realistic approach is probably to think of the price regulation as being conditioned on certain minimal standards and than to allow the regulation of quality to undertaken via one or more partial add-on models of the cost increases (decreases) that will be allowed for certain increases (decreases) in quality. This is the approach we shall discuss here. What is forgone by this approach is the possibly interaction of quality of quantity and the possible gains from bundling quality and quality signals.

Ex ante or ex post regulation

4.11 Just like in the regulation of revenue, the regulation of quality can be based on both ex ante mechanisms, where the regulator specifies the targets and the consequences of deviating from these for a given period of time, and ex post mechanisms, where the targets are set endogously in the period in question by the performance of similar firms. When it comes to quality, the usage of ex ante mechanism may have some advantages due to the high level of idiosyncratic risk involved. A moving target based on random outcomes from peer units may impose unnecessary risk on the firms. We shall therefore focus on ex ante schemes below.

Steering mechanisms

The natural next question is how the regulator can steer the firms (or consumers) to choose the adjust the optimal level. There are several such ways as discussed in more details in NEMESYS (2005b). Here, we shall simple consider two regimes.

4.12 The first and traditional possibility is to use a *restriction based plan* similar to the familiar minimal requirement approach in electricity distribution. In this scheme, the reimbursement to the firm equals A if it comply with minimal standards and the penalty otherwise is very large

$R(q) = A$ if $q>=0$ and very negative otherwise

Again, the lump sum amount A can be chosen as any value between 0 and $B(q^{opt})-C(q^{opt})$. High values means that all the gains from adoption to optimal quality goes to the firm and low values that the gains go the consumers. This scheme is illustrated in Figure 4-2. below.

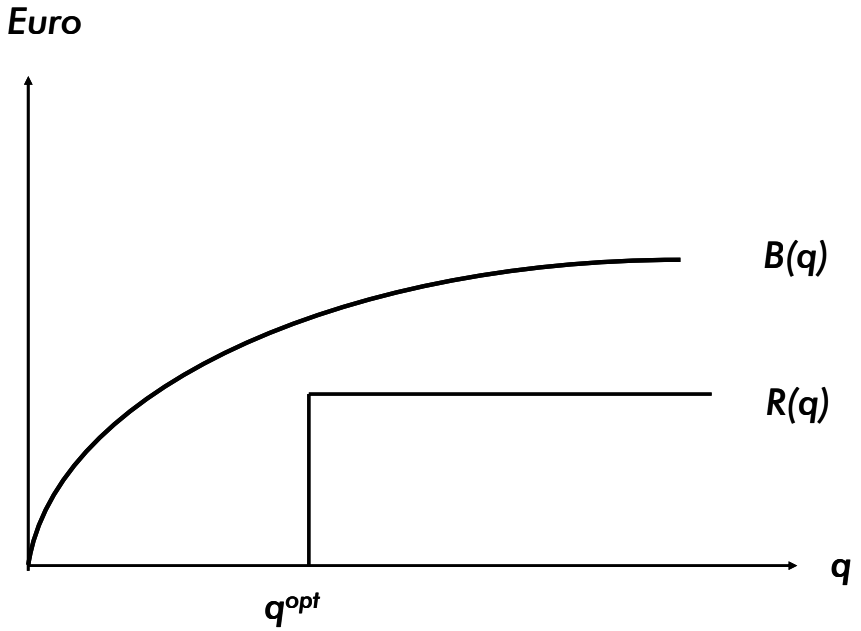

Figure 4-2 Restriction based scheme

The advantage of this scheme is its simplicity making it easy to convey and to adapt to. On the other hand, its optimality is extremely sensitive to variations in the cost and benefits function. It is therefore primarily useful in those cases, where the benefit or cost curves are linked with a sharp decrease in marginal value or a sharp increase in marginal costs at q^{opt}.

4.13 The other is to use a so-called *marginal-price scheme* where the firm is paid a lump sum amount A plus a relative small price for quality variations around the estimated optimal level. This price shall ideally reflect the marginal benefits to the consumer segments served by the DSO in question (and it therefore may vary between and different regions.)

4.14 Formally, the scheme can be written as:

$R(q) = A + pq$

This scheme is illustrated in Figure 4-3 below.

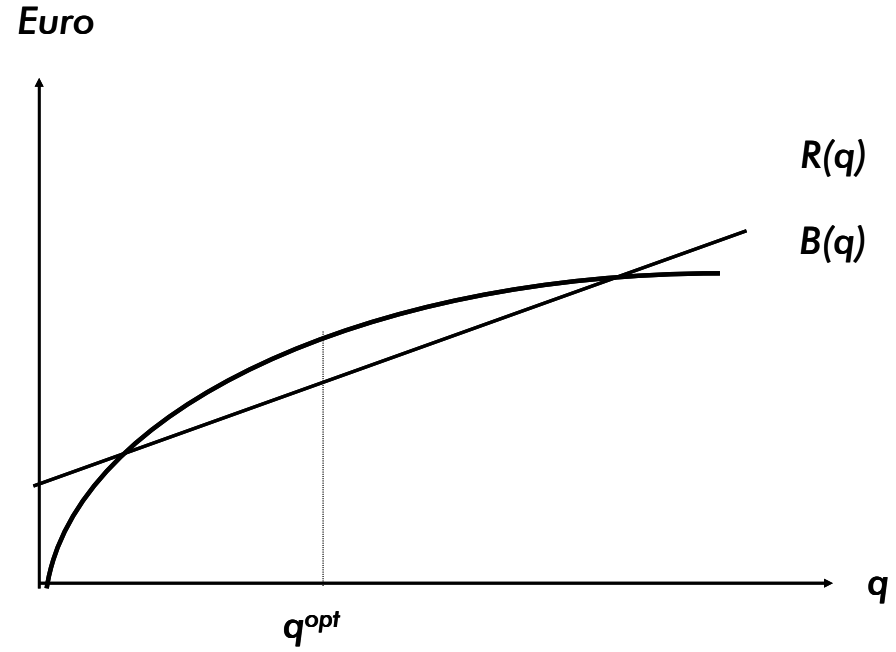

Figure 4-3 Marginal price scheme

The advantage of this scheme is its relative simplicity making it easy to convey and to adapt to. Also, if the anchor point, the estimated optimal level. is not correct, the scheme will still give incentives of the correct direction. Over time, and if the regulator review the marginal prices over time, an adaption to the optimal level can be foreseen. On the other hand, the estimation of marginal value in optimum must be rather precise.

Robustness to changes in costs and benefits

4.15 As mentioned both schemes requires information about benefits and costs. Since such information is noisy at best, it is important to consider the impact of having mis-specified costs and benefits – or to have changes in costs and benefits over time.

4.16 One more general economic result indicates, however that this problem should not be exaggerated. The result is known as the envelope theorem. It says that so-called first-order deviations in the estimation of economic choices may only have a second order economic impact. In the present case, let

$N(q)=B(q)-C(q)$

Denote the net benefit and let us assume that we have estimated the optimal q to q* rather than q^{opt}. Assuming differentiability and making a so-called Taylor approximation of N(q) we get

$N(q^*)=N(q^{opt})+N'(q^{opt})(q^*-q^{opt})+0.5N''(q)(q^*-q^{opt})$

for some q between q* and q^{opt}. Since $N'(q^{opt})=0$, we see that the difference between N(q*) and $N(q^{opt})$ will not be too large unless the net-benefit function is strongly curved. See also Akerlof and Yellen(1985).

Implementation

4.17 Traditionally, quality decisions are delegated to the firms and indeed this is the perspective we have used here. This is particularly relevant when we consider common regimes where all customers by the public goods character are going to enjoy the same quality level.

4.18 For other quality attributes however it is possible to let the consumers decide, either trough consumers associations or an individual basis. This could be the case for example if voltage quality or more obviously, for some of the individualized business qualities.

4.19 A key question in the *allocation of decision right* is who has the best information. If the costs are relatively stable and foreseeable but the benefit structure is hard to elicit, the consumers should be allocated the decision rights and they should pay a lump sum for this right. If on the other hand benefits are relatively well described but costs are complicated and likely to vary over time, the firm based regime is preferable. We suggest that the latter is the case.

4.20 It requires a reasonable amount of *information* about costs and benefits to determine the (near) optimal quality level as illustrated in Figure 4-3 above. It typically involves a good approximation of the consumer benefits as can be determined using preference revelation techniques. Likewise, it also requires a good understanding of the technical possibilities to adjust the quality provided.

4.21 We shall discuss neither of these aspects here. We note however that it has been done with some success in the DSO industry before, with Norway and the Netherlands as interesting examples.

4.22 Also, we suggest that the asymmetric information is more important when it comes to the cost of quality than to the benefits of quality. Truly, there may be considerable uncertainty as to the quality benefits but this uncertainty is more evenly distributed. The regulator will typically be just a capable of doing consumer surveys and estimating benefits to different demand segments as the individual DSO will be. The local knowledge is more important when it comes to the technical solutions.

4.23 This has implications also for the choice of regime. It may be better to give the DSO price incentives than to try to define the optimal quality level in the different regions.

4.24 Let us close by mentioning also that while we have looked at simple schemes with just one dimension here, real quality incentive schemes will usually be multiple dimensional. Several quality aspects will have to incentivized, one way or the other. Given the nature of the dimensions, a price or a restriction based regulation may be optimal. This suggest that real systems should be *hybrid systems*, where a number of quality attributes are incentivized using prices and where others are controlled using minimal requirements.

Conclusion

4.25 Quality regulation and in particular the provision of incentives to make appropriate quality adjustments is important in regulation – and in particular in a regulatory context where the incentives to reduce costs are subject to quite high powered schemes.

4.26 Based on the asymmetry of information about costs and benefits, we have identified a simple but nevertheless potentially very useful approach to the regulation of DSO quality, namely the marginal cost approach.

5. NEMESYS Regulation Approach

Introduction

5.01 This chapter provides an in-depth description of the proposed revenue yardstick model and the quality incentive model, their background, properties and application in the chosen regulatory approach.

A Nordic consensus

5.02 The system analysis (cf. NEMESYS, 2005a) shows a fairly common view on the objectives, organization and principles for the energy network regulation. Besides differences of institutional, historical and legal character, there are no insurmountable obstacles to a further harmonization. However, the regulators are appointed nationally, which means that a proposed joint approach must bring considerable and tangible benefits to each country for it to be worthwhile. No regulator would ever accept to degrade a given national system to a less adequate regulation, harmonized or not. The key issues to meet in this context are *investment incentive provision, output focus* and *quality of service*.

Investment incentive provision

5.03 The Nordic grids are aging and the next wave of investments needs to be made under a new regime. Increased private ownership will put higher pressure on clear and favorable investment incentives in order to unblock capital. Nationalization of grids is impossible, municipalities are selling off their infrastructure, and consolidation takes place across the Nordic countries. The regulators are deeply concerned with the creation of viable incentives for investments, as this relates to quality and the viability of the regulation. Hence the new regimes need to be attractive in terms of incentive provision, offering true rewards for both efficient operation, restructuring and reinvestments.

Output focus

5.04 All regulators are heading for an output-based and high-powered regulation, in particular Norway and Sweden are irreversibly committed to this track. Although the Directive actually allows various low-powered possibilities, the transition from low-powered regimes to high-powered is one-way in all sectors. This trend is consistent with the incentive provision, but is also a result of mixed national experiences with other regimes (CPI-X, light-handed) that failed to convince in the long run. The interest in this reorientation is mutual between regulator and the firms, although smaller firms may feel a further push for restructuring. We advocate that the proposal should be forward-looking and output-focused.

Quality of service

5.05 The new Directive, national regulators and ministries are unanimously evoking quality provision as a major objective for the future. Repercussions from network failures are extreme illustrations of the vulnerability of the society and carry high

cascading costs, both economic and political at national, regional (NordPool) and European (integration) levels. However, the approach of detailed national restriction-based regulations is too cumbersome and lacks credible economic incentives. EU through SESSA has signaled that quality should be a matter of regulatory concern, pointing at the Norwegian KILE as best practice. Hence, we need a solid approach to quality provision that meets the requirements of current and potential new technologies.

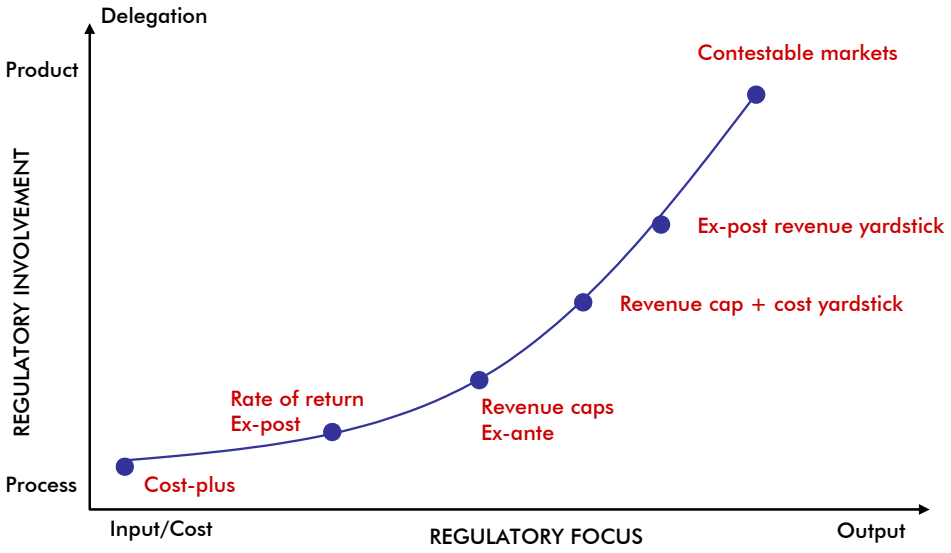

Figure 5-1 Dynamic developments in regulation involvement and focus

Regulatory enablers

5.06 In this section, we treat some important requirements for the implementation process of the pan-Nordic model, beginning with the task definition in Figure 5-2.

Definition of Core DSO tasks

5.07 Any coordinated regulation system requires a clear definition of the least common subset of DSO tasks, the *Core DSO Task* (cf. NEMESYS, 2005c). Although the definition may be done fairly rapidly, the true implication is that information acquisition should be decomposed in the core task to allow for straight-forward comparisons, which might require some changes of the national reporting systems.

Definition of Nationally Regulated DSO tasks

5.08 National regulators may still have justified needs to define DSO activities that are not harmonized in the Core DSO Task. This could apply to e.g. tasks related to safety inspections, line dismantling and energy planning. We denote such regulated obligations *Nationally Regulated DSO Tasks*. All compensation for such tasks should be transparent (and preferably based on tendering) to avoid cross-

subsidies to incumbents. To maintain this transparency and promote development, we propose that the regulated payments for the National Regulated DSO Task should be separated from the Core DSO Task. In practice, this could render these tasks more attractive to non-DSO providers or at least informing the regulator of the real costs involved to permit social trade-offs.

Definition of Other DSO tasks

5.09 Activities that are not regulated, but compatible with the national and European directive with respect to non-discrimination, independence and competition, will be called *Other DSO Tasks* and will be left to residual competition law. In our approach, such competitive activities can be freely performed as so far as they bring coordination gains.

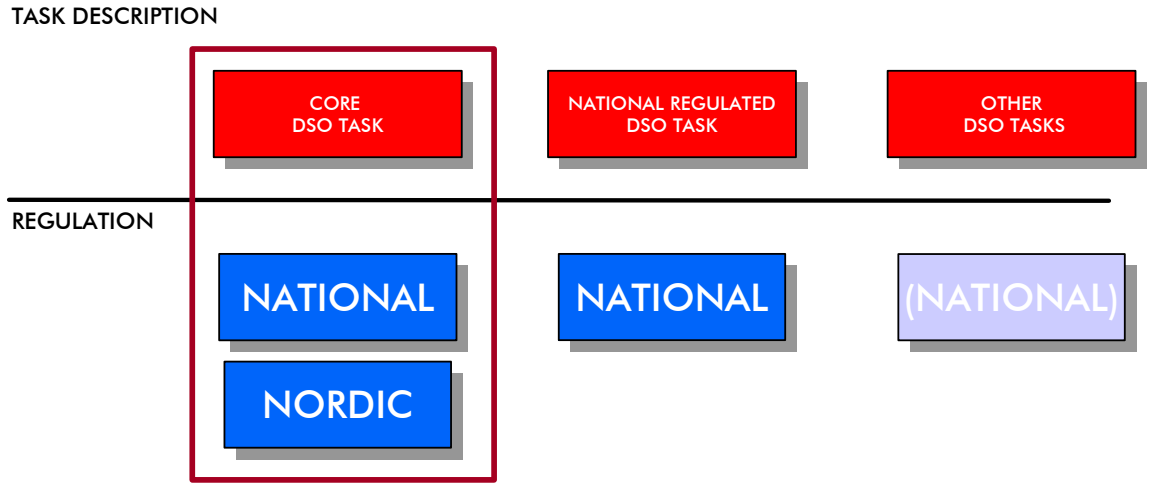

Figure 5-2 DSO Tasks and corresponding reguatltion.

Framework agreement

5.10 There needs to be a common regulatory vision statement for both model structure and the time plan by all regulators. This does not mean a streamlined legislation, but a high-level commitment to the principles and tools for all further revisions.

5.11 A fully integrated regulatory body like NORDREG could easily administer the regulation, but the proposal is flexible with respect to institutional solution. The competency to define national marginal prices, extra DSO tasks and to define concession areas is also a national prerogative, as all monitoring of the non-economic and equity aspects of the directive.

Common information system

5.12 The proposal, as any quality-oriented, output-based regulation needs access to high-quality data in common formats, but so does the sector itself for its coordination and restructuring. We propose a common client metering standard, including format for transmission of hourly data, connection and disconnection.

We propose that the meter standard defined by a "third party", formally responsible for the metering, reporting and administration of technical data from customer level to other parties. This is a typical coordination task that normally does not result from independent action by firms in coexisting regulated systems, with impact on the administrative costs for market facilitation, restructuring (mergers) and control. The *Metering Agent* owns the park of meters and carries the responsibility for the entire data chain in return for a fixed reimbursement per transaction and meter to cover its expenses. Any efficient provider, such as a DSO, can carry out relevant work under bilateral agreements with the Metering Agent.

Financial conditions

5.13 To increase transparency and avoid regulatory competition, the regulators need to coordinate the financial conditions also for Nationally Regulated DSO Tasks. However, this should be seen in connection with a common information system, leading to equal performance criteria in e.g. reliability and commercial quality. Note that this does not mean that the average realized profits need to be equal in all countries, since they are the outcomes of the regulation itself.

The Revenue Frontier Yardstick Model

5.14 To achieve a radical, yet realistic proposal to (i) get rid of the input-dependency of the regime and (ii) create common incentives in the Nordic countries, we advance a revenue yardstick model, built on final price rather than cost competition.

5.15 First, what matters is price = revenue, not cost in the yardstick, i.e. the return on investment is endogenous and not regulated. Tariff levels are set by all firms and regulated ex post depending on "value for money" set by the other firms. In this way, firms may budget for reinvestments prior to investment, rather than the jerky and artificial problem of network age.

5.16 Second, the regulators agree on a common incentive power for the model to avoid cost pass-through between countries. However, they still do not need to harmonize the add-on tasks, as long as they can be reimbursed separately by each national regulator (using e.g. ABC techniques).

5.17 Third, the yardstick model is harmonized, as opposed to the use of national yardstick models.

The scheme

5.18 The revenue yardstick model defines the *revenue base* RB(t) for a given DSO in period t as

$$RB(t) = C^*(t-2)$$

where C*(*t*-2) is the *yardstick revenue* for period t-2 determined by the benchmark model estimated on the data from all other DSOs but the one in question (super-efficiency evaluation), cf. below.

5.19 The (benchmarked) *DSO charges* in period t-2, C(t-2), may deviate from the yardstick revenue. If the charges have exceeded the revenue yardstick, it corresponds to the DSO having taken a loan with the consumers. If it falls short of the yardstick revenue, it corresponds to the DSO having provided a loan to the consumers. These loans should be repaid with interests.

5.20 We shall think of these as *carry forwards* in period t, CF(t), i.e. we have

$$CF(t) = \begin{cases} (1+\alpha)\cdot\left[C^*(t-2) - C(t-2)\right] & \text{if } C^*(t-2) \geq C(t-2) \quad \text{(under - charged)} \\ (1+\beta)\cdot\left[C^*(t-2) - C(t-2)\right] & \text{if } C^*(t-2) < C(t-2) \quad \text{(over - charged)} \end{cases}$$

The parameter α is the two-period borrowing interest rate in period t-2 and $\beta = \alpha+\delta$ is a lending rate that exceeds the two period costs of borrowing with some extra penalty $\delta>0$. In the following, we shall think of a period as one year.

5.21 The sum of the revenue base and the carry forward defines the *revenue target* for period t

$$RT(t) = C^*(t-2) + CF(t)$$

This revenue target is *indicative*. It defines the actual charges the DSO in question should make in period *t* to come out on equal footing with the other DSOs presuming that they do not change from period *t*-2 to period *t*. The indicative revenue target can be used by the regulator when ruling on or confirming actual charging proposals AC(t) for period *t* at the end of period *t*-1, cf. below. Exactly how the regulator rules here is not very important for the incentive properties of the scheme and the regulators in the different countries need not even use the same principles. What is important for the convergence and the compatibility with the Directive is that the methodology for determining the revenue yardstick and target is defined ex ante.

5.22 In period t the actual charges of the DSO is

$$AC(t)$$

The actual charges will however reflect not only the costs and profits to the DSO in period t but also the need to repay a negative and the right and obligation to collect a positive carry forward. Therefore, the real in-period DSO charges in period t, the benchmarked charges BC(t), is

$$BC(t) = C(t) = AC(t) - CF(t)$$

The benchmarked charges form, together with the provided services, the basis for the benchmarking exercise that set the revenue base RB(t+2) for period t+2, i.e. C*(t).

5.23 We have hereby outlined a full regulatory circle.

5.24 To illustrate, assume that all DSO collects 100 in 1998 and that everyone except the DSO in question continues to do so in year 2000. This implies that there is no carry forward in year 2000 for any DSO and that the minimal revenue collected by other similar DSOs in year 1998 be C*(1998)=100. The revenue base and the revenue target in 2000 therefore coincide and equal RB(2000) = RT(2000) = 100. Assume now that the DSO in question collected only C(2000) = 80. Now, if the interest rate is 10% in two years, the carry forward in year 2002 is CF(2002) = (1+10%)(100-80)=22, and the indicative revenue target is RT(2002) = 100+22 = 122. If the DSO in year 2002 collects AC(2002) = 110, it corresponds to an effective and benchmarked charge of BC(2002) = 110-22 = 88. The DSO in question therefore generates a positive carry forward in year 2004 as well equal to (1+10%)(100-88) = 13.2 (presuming that the others continue to collect an effective 100 in year 2000). An extended example is provided in the next chapter, where we will also follow the impact in the other DSOs from the low charges made by the DSO in question here.

The intuition

5.25 The intuition of the revenue yardstick model is as follows:

5.26 In period t-2, the DSO is first and foremost allowed the efficient tariff charges, C*(t-2). This is in direct line with the incentive theory and the optimality of DEA based yardstick costs when costs are non-verifiable.

5.27 For practical purposes, however, the allowed income is determined based on data with a two period delay. This will allow the regulator time to collect data from period t-2 during the first half of year t-1, and to calculate the allowed revenue for period t during the last part of year t-1. The DSO and regulator can therefore settle on period t charges a priori. This has two advantages compared to a direct implementation of the revenue yardstick without time-delay. First, it allows a DSO to close its financial statement according to normal procedures. Secondly, it ensures that the regulation comply with even strict interpretations of the EC legislation.

5.28 Also, the scheme takes into account that the DSO may ex post have charged below or above the yardstick level C*(t-2). If the DSO has charged less, C*(t-2)>C(t-2), the DSO has basically been lending the difference to the customers. The DSO is rewarded for this by the interest on the loan. Likewise, if the DSO has charged more than the benchmark level, C*(t-2)<C(t-2), the DSO has effectively borrowed from its customers. Again, this loan must be repaid – and with interests.

5.29 Lastly, the model works with asymmetric interest rents. Under-charging carries the normal interest rate α. Over-charging must be paid back using a higher rate β. In principle, the scheme is incentive compatible even when lending and borrowing carry the same interest rate, $\beta = \alpha$, but to make the scheme more high powered, and clear we propose to add an extra charge $\delta>0$ in the case of over-charging. Coupled with the uncertainty of the yardstick level, this will give the DSOs extra incentives to reduce charges.

5.30 The revenue yardstick scheme is illustrated in Figure 5-3 below. The minimal costs of an efficient DSO is below the yardstick level as indicated with a non-filled point, but the DSO can choose to charge the consumers more or less as indicated

by the solid points on the vertical line through the minimal cost point. Overcharging occurs when the charging exceeded the yardstick level.

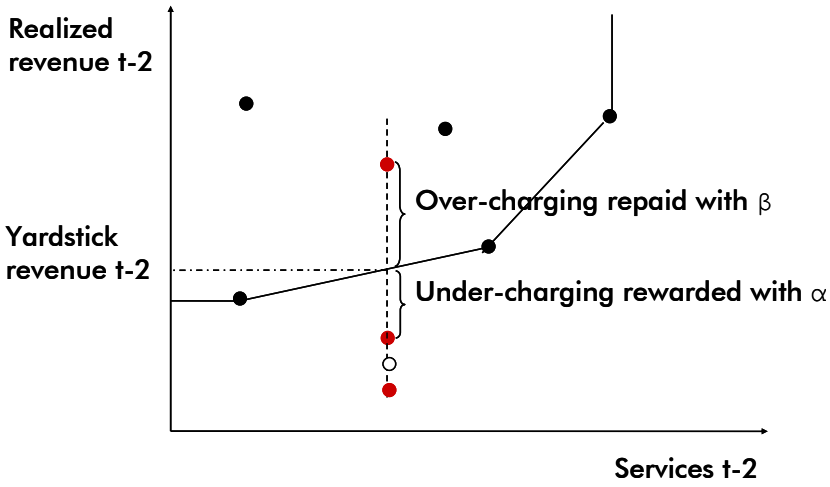

Figure 5-3 Yardstick revenue scheme

Incentive effects

5.31 The proposed scheme has clear similarities to the yardstick regulation discussed in details in the previous chapters. However, it also deviates by focusing on realized revenues rather than realized costs. It is therefore worthwhile to make a simple analysis of the incentive properties.

5.32 The proposed scheme gives the DSOs incentives to participate and to reduce tariffs to the smallest level that is consistent with continued operation. We will discuss and illustrate this in more detail below. To show the basic logic however we provide a simple "proof". We consider a one period situation and assumes that there is therefore no carry-forwards to take into account.

5.33 Consider a (profit maximizing) DSO with minimal total costs c. The tariffs that it charges will be C. The charges can exceed the costs, C>c, corresponding to inefficient operations or excess profit charges. The charges can also fall short of the costs, C<c, corresponding to a tariff level that is not sustainable in the longer run since the DSO will earn below normal returns on its capital investments. Finally, let the benchmarked tariff levels of the other DSO be C*. Assuming that the others maximize profit as well and that the benchmark model is correct (or at least gives a conservative estimate), we will then have $C^* \geq c$.

5.34 Three possible outcomes can now be distinguished. The DSO can choose charges in RegionA: above C*, in RegionB: between c and C*, or in RegionC: below c. Choosing in RegionA is not a good idea since it effectively costs the penalty $\delta(C-C^*)$. Choosing in B would work since whatever it saves compared to the benchmark carries a normal interest. Still, this is a dangerous strategy since the DSO cannot foresee C* with certainty, so for any C>c, there is a chance that it will end up paying a penalty. Lastly, charging C<c, is possible – but not optimal since

the losses is only compensated with the normal interest rate and there is no gains in terms of reduced risk (presuming once again a conservative benchmark model).

Merger rules

5.35 In case of mergers, we propose that the allowed revenue shall simply be the sum of the revenues until the period t where the merger has already been effective for two full years. That is, assume that two or more DSOs merge at the beginning of period t. Then the allowed revenue in period t and t+1 is still the sum of what they would have been allowed as individual DSOs in both year t and year t+1. In year t+2, however, the calculation will take into account that the units merged in year t and the units will be dealt with as a single unit.

5.36 This rule is simple, it complies with EC requirement of ex ante regulation, and it does not delay the normal procedures of closing of the financial statements. Moreover, if the merger is efficiency enhancing, the consumers and not solely the DSO gains right away because the DSO has strict incentives to lower tariffs to reduce the risk of paying the extra δ.

Model specification

5.37 To calculate the revenue benchmarks in the proposed regulation, we need information about inputs, outputs and environmental variables. The inputs are denoted x or c above and the outputs and environmental variables are denoted y. Extended discussion of alternative model specifications, including variable choices, are provided in NEMESYS(2005c). Here, we simple make a few general observations.

5.38 On the input or cost side, we need the *revenue levels*. Since the total relevant cost includes all operating, capital and financing charges, cost pass-through can be limited to standard costs for net losses, transmission charges, non-distribution tasks and taxes.

5.39 On the output or *services* side we recommend international practice – taking into account of course the special possibilities in the well-developed Nordic region. The scientific as well as the technical literature converges on an output specification that reflects three dimensions:

- customer service
- transportation work
- capacity provision.

The first dimension is usually covered by the total number of clients, potentially divided into voltage levels or market segments. The second corresponds to total delivered energy, if needed differentiated by voltage level. The third dimension is covered by proxies for capacity such as installed transformer power or peak power.

5.40 In terms of *environmental* variable, it is important to explicit account for "objective" differences in the costs of distributing electricity without implicitly justifying inefficiencies. We therefore recommend that the environmental variables are restricted to those that are truly *exogenous* (imposed), and that has a *significant* and *durable* impact on the total costs of a DSO.

Return to scale

5.41 One of the crucial properties of the regulatory benchmarking model is the return to scale properties. Again, it is beyond the scope of this project to make definite recommendation of this aspect. However, we do note that may studies of Nordic nets as well as the preliminary data analysis in NEMESYS(2005c) suggest that a specification involving constant return to scale may be reasonable.

5.42 Constant return to scale means that when costs are increased (or decreased) with a given factor, then all outputs can increase (must decrease) with the same factor.

5.43 In addition to empirical findings, the constant return to scale specification has important regulatory justifications. Unless there is a clear and well-founded regulatory agenda related to industrial structure, the model should not give bias to any specific industrial organizational form. The stake-holder analysis in NEMESYS(2005a) also supports the idea of the regulation being neutral to organizational form. Of course the exact interpretation of this is not clear, but assuming some willingness to change concession areas and allow mergers, this would in the long run point towards a constant return to scale assumption. If we want to allow for very special geographical conditions (islands etc), we might relax that and use a non-decreasing return to scale specification.

DEA model

5.44 To approximate the underlying cost function, C*(y), we would recommend the use of Data Envelopment Analysis (DEA), such that all firms are benchmarked against a Reference Set containing all admissible observations (not operating at a loss) less their own performance. This arrangement fulfills the yardstick properties stated in Chapter 3, since it provides incentives for all firms (efficient as well as inefficient) to improve tariffs and costs.

5.45 The non-parametric DEA model is firmly rooted in the incentive theory that underpins applied regulation economics. Under some very general assumptions, the model assures participation and incentive compatibility when used as a yardstick element in regulation. Alternative models, based on partial measures or non-frontier econometrics, do not share these properties and their "simplicity" thus comes at a high price in regulatory viability.

5.46 In addition to the incentive advantages, we recall that DEA offers a flexible approach that allows good models of production and cost structures without imposing too many and possibly arbitrary a priori restrictions on the assumed technology. The advantages of DEA as a modeling tool is widely accepted, in particular in cases where the data are of good quality and where the number of firms is large as in a pan-Nordic sample. Note also that the single most difficult problem in most regulatory benchmarking models is the creation of good capital cost measures. This problem is eliminated by our use of a revenue yardstick model. Therefore, the data quality in any implementation of the above proposal will be higher than what has typically been seen.

5.47 Despite of these likely improvements in the data, the well-known sensitivity of DEA models to noise and the bias of the costs estimates in less dense "regions" suggest that the benchmarking must be undertaken with great care. Also, as discussed in

Chapter 3, it may be worthwhile to work with revenue norms somewhat above the DEA estimated one, i.e. to use 1.1C*(t) instead of C*(t), in the scheme above. These aspects however are details of the regulatory system and calibration that are beyond the scope of this project.

Hyper-efficiency

5.48 The use of super-efficiency together with DEA creates a possible technical problem, sometimes referred to as hyper-efficiency. If a given DSO has a special output profile that do not resemble the output profile of any combination of other DSOs, the yardstick revenue C*(y) may be infinite when C*(y) is estimated using DEA.

5.49 This problem – and theoretically sound ways to cope – is discussed in some details in Agrell, Bogetoft and Tind(2005).

5.50 One approach is to introduce additional information. Exactly how to do so depends on the context but some quite obvious options include the use of (i) historical data to extend the data base, (ii) technical norms, e.g., as derived for detailed engineering studies, (iii) partial price information, or (iv) supplementary runs with a parametric model. The first two options have been discussed in Bogetoft (1997) and Bogetoft (2000). The potential power of the third approach has been demonstrated by Olesen and Petersen (2002). The usage of the fourth approach is discussed in more details in Agrell and Bogetoft(2005).

5.51 From a more practical and less theoretical point of view, there are several additional "solutions". One may introduce additional assumptions about the technology. The use of a constant return to scale assumption (compared to one of variable return to scale for example) will tend to limit the problem. Also, one may assume a functional form (cf Bogetoft (1997)) or otherwise extend the production possibility set. Such extensions may lead to well-defined schemes, but unless the underlying assumptions are valid, the solutions will not necessarily be optimal in any strict sense, i.e. as the solution to a theoretically sound contract design problem.

5.52 Another way to modify the informational foundation is to make more active use of the unit's revenue level. If we include the evaluated unit in the benchmarking model, the hyper-efficiency problem do not exists. On the other hand, this creates an incentive problem. It would give the DSO an incentive to increase tariffs because it has little interest in competing with itself. The strength of these adverse incentives however is more limited in an actual application where the DSO does not know the outcomes of the other DSOs. That is, taking into account the uncertainty faced by the DSO, it may still be optimal to minimize tariffs.

Collusion prevention

5.53 One may object to the idea of using tariffs rather than costs as being a naive invitation to collusion, since prices are easier to control (rig) than costs. In theory, the DSOs could run the yardstick model ex ante to assign prices to extract any possible profit. However, the situation is analogous to tendering on a competitive market, say for ambulance services. In competitive markets, it is exactly the task of the regulator, i.e. the competition authority, to monitor and counteract collusive

arrangements. The proposed regulatory approach is now turning the attention of the regulator from the operations of the distribution business and more to market design and, just precisely, competition law. Given that the revenue market model has the sound property of penalizing overcharges, there is no reason to believe that the distribution sector would be more prone to completely rigging a four-country market with over 400 participants under mixed ownership, private, municipal and cooperatives.

5.54 Still, if the calibration and simulation of specific models should indicate that there are considerable coalition risks, the proposed regulation parameters, in particular the interests and penalty levels may be adjusted. Also, one may consider off-equilibrium mechanisms like the so-called Principal's Pet to police the industry and to kill unwarranted equilibria at no extra costs.

Quality incentive scheme

5.55 As discussed above and in Chapter 4, the quality dimension is ever more important for the network regulation at all levels. The ability of the regulation to adequately and credibly provide incentives for long-run quality provision will be one of the acid tests for the regulation. Three dimensions emerged from the analysis in Chapters 2 and 4 above; (i) the quality steering, (ii) the information requirement, and (iii) the timing of information and settlement (ex ante, ex post).

5.56 First, supported by the theory and the scientific consensus of SESSA (2005), we conclude that a regulation for electricity distribution that is entirely restriction-based is likely infeasible in the long run. However, the large number of measurable dimensions (NEMESYS, 2005c and 2005d) suggests that a hybrid approach using restrictions is interesting, since many of them are subordinate or correlated to reliability of supply. Thus we argue for the explicit inclusion and marginal pricing of reliability of supply, measured in the two dimensions ENS and SAIFI, where the latter

1) ENS (Energy Not Supplied, GWh), defined at client connection level (<1 kV) for interruptions longer than one minute, divided into notified and non-notified interruptions.
2) SAIFI (System Average Interruption Frequency Index), defined as the number of sustained interruptions reported at distribution delivery point (<1 kV), irrespective of interruption time, divided into notified and non-notified interruptions.

Other quality aspects, related to voltage and commercial quality, are proposed to be defined with target and threshold values in the DSO Task Description, preferably jointly with clients and industry organizations. European standards, such as the "indicative values" in EN50160 for voltage quality could be a starting point for such definitions. A client should be able to expect the target level for any restricted quality dimension, but temporary and moderate deviations above and below the value are acceptable. Violations, measured as averages over time as appropriate for each dimension, of threshold values should trigger a regulatory review. Unless concrete measures are taken by the violating DSO to remedy the quality problems, the national regulator may revoke or suspend the operator's concession.

5.57 Second, technical data regarding reliability and voltage quality should be collected and reported in a regular and standardized fashion from the level of connection point, if applicable. Current diverging metering standards and incompatible

information systems complicate this task, which may be costly for small DSO. For this reason and to ensure a consistent and simplified harmonization of the exchange of all output-based data, we propose that the national responsibility for the definition, processing and reporting of metering is assigned to a unique operator, see enablers below.

5.58 Third, for reasons of visibility and commitment, we propose a strict application of an ex ante marginal pricing scheme (cf. Chapter 4) on reliability. That is, while the tariff levels should be regulated by a yardstick scheme with the advantages of ex post evaluations, we propose that quality is regulated using a strict ex ante approach. The Quality Incentive Scheme is based on ENS and SAIFI data collected per customer segments for each operator.

5.59 The proposed scheme has similarity with the Norwegian CENS (Cost of Energy Not Supplied) as originally described in ECON (2000). A new project has been initiated in Norway (NVE Seminar on Future Regulation, 31.03.2005). Compared to the Norwegian CENS regime, the quality regulation involves a series of important improvements to get a better adjustment of realized quality levels to the socially optimal ones. Similarly, the proposed regulation resembles that implemented in the Netherlands. The proposed approach also has similarities to the Swedish customer reimbursement system although care should be taken to avoid unnecessary administrative burdens.

Compensation scheme

5.60 The marginal price scheme with k different quality dimensions can – following the theory in Chapter 4 - be written as

$$Q(q_1, q_2, ..q_k) = A + \sum_{j=1}^{k} p_j q_j$$

where Q is the quality payment to the DSO, q_j is the supplied level of quality dimension j, and A is an up front payment. We will discuss how to set these parameters below.

5.61 The parameter A determines - in part - how the social gains of balancing cost and benefits of quality is shared among the DSO and the customers. The size of A shall however be seen in connection with the choice of anchor-point and the choice of possible up-front payments in the revenue yardstick regime, cf. below.

5.62 The quality reimbursement shall be added to the allowed revenue according to the revenue frontier yardstick model to form the full regulated revenue to the DSO. Specifically, this can be done by including the positive or negative quality charges in the carry forwards into a *carry forward with quality* CFwQ

$$CFwQ(t) = CF(t) + (1+\alpha)Q(t-2)$$

so as to settle these with a two year delay.

Different starting points

5.63 The quality incentive payment above can of course be reformulated using different "anchor points". The choice of the anchor point has no incentive effects but one formulation may be easier to appreciate than others.

5.64 We note in particular, that we could anchor the model around the historical quality levels. If we let q_i^H be the historical value of quality dimension j, the quality incentive payment could be

$$Q(q_1, q_2, ..q_k) = \sum_{i=1}^{k} p_i [q_i - q_i^H]$$

where we have now chosen $A = -\sum_{i=1}^{k} p_i q_i^H$. The logic of this scheme is that a DSO is rewarded for any improvement in quality and penalized for any deterioration in quality compared to the historical levels. This would resemble the Norwegian system where a DSO can both be rewarded for improving performance and penalized for falling quality performance.

5.65 An alternative formulation – leading to the same payments for similar performances but a different interpretation - would be to anchor the scheme at the maximal quality levels corresponding to no interruptions and no loss of energy supplied. In this case, any deviation will be on the down-side and consumers shall be compensated. If the maximal level is denoted q_i^M in quality dimension j, the quality incentive payment could be

$$Q(q_1, q_2, ..q_k) = \sum_{i=1}^{k} p_i \left[q_i^M - q_i^H\right] + \sum_{i=1}^{k} - p_i [q_i^M - q_i]$$

where the first term represents an up-front payment to the DSO for the ideal provision of maximal quality and the last term represents the payments by the DSO for less than maximal quality provision. This would be close to the Swedish regulation where customers are compensated for interruptions (cf. NEMESYS, 2005a)

Base level

5.66 The preferred equilibrium point (base level) of ENS and SAIFI is to be determined once for each operator and concession area, without updating, using statistical, technical and socio-economic analysis. In the analysis care should be taken to include the environmental, load and service factors that have an impact on historical reliability.

5.67 Although it is beyond the scope of this project to further specify such mission, we note that the base levels should ideally be determined as the optimal quality level in the different dimensions of ENS and SAIFI. The optimal levels, the base levels, trade off the benefits to consumers against the costs to the DSO of providing quality. The base levels will depend on the country and the DSO. In fact, they should ideally be determined at the customer level – or at least at the lowest level for which measurements are and quality controllable.

5.68 It is important to understand that the base level is not the historical level. Rather it is the optimal level given the present values of the consumers and the technological possibilities of the DSO. To determine appropriate base levels, therefore, one need good information about the consumers benefits and the DSO's costs of adjusting quality. The first involves willingness to pay studies and the latter involves technical evaluations possibly supported by benchmarking studies.

Marginal prices

5.69 For each customer segment, defined without ambiguity based on type of connection, the regulators determine for a ten-year period marginal prices per unit of energy not delivered (ENS) and outage occasion (SAIFI), for notified and non-notified interruptions, respectively.

5.70 The marginal prices correspond to the marginal costs (=marginal benefits) at the optimal base levels in the different quality dimensions. The setting of base levels and marginal prices is illustrated in Figure 5-4 below.

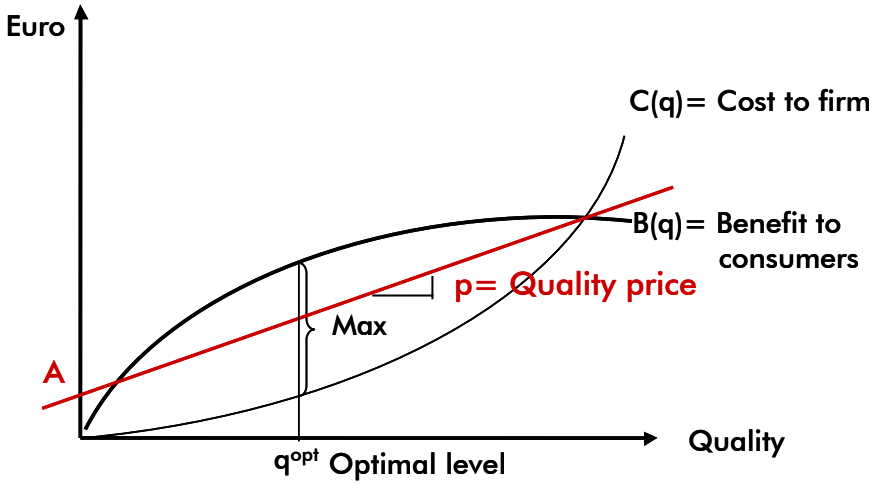

Figure 5-4 Quality regulation

Regulatory settlements

5.71 Based on objective and verifiable measurements of ENS and SAIFI at customer level compensations to individual customers can be calculated and the customers can be reimbursed with a time delay corresponding to the one used in the revenue regulation.

5.72 To the extent that ENS and SAIFI cannot be measured and controlled at customer level, then the lowest, most customer close measure points shall be used. In these points, the ENS price will equal an average of the consumer based prices below while the SAIFI price will be the sum of the SAIFI prices for the customers below.

5.73 To avoid unnecessary administrative burdens, small consumer reimbursements could also be accumulated on a solidarity account and be used to lower the general charges to the DSO's consumers.

The regulatory procedure

5.74 The proposed regulatory procedure is illustrated in Figure 5-5 below for the three parties DSO, regulator and metering agent.

5.75 After closing the accounts for year 1, the DSO reports in an electronic format the financial data for Core DSO Tasks, National Non-Core DSO Tasks, and Other DSO Tasks, the service data that corresponds to the variables of the yardstick model, and the relevant concession data concerning the grid and the operating environment.

5.76 The Metering Agent, or the DSO by delegation, reports low-level reliability data for year 1 and total supplied energy from higher grids.

5.77 The regulator validates the deduction of the regulatory settlement for the preceding year, charges to higher grids, standard costs for network losses, National Non-Core and Other DSO Tasks from the submitted total revenues. If the Net Revenue is negative, the firm is deleted from the Reference Set, otherwise not.

5.78 The revenue yardstick model is run for all firms, using the comparators in the Reference Set, and the Efficient Revenue for year 1 is calculated for each firm.

5.79 After validation, the quality data is processed in the quality incentive scheme and the result can be either negative or positive. In the first case where less than optimal quality has been supplied, the result shall be processed as an ENS compensation to be paid out to consumers year 3. To limit the administrative burdens, we may choose only to compensate individuals when the compensations exceed a given threshold, and to simply pool small amounts and use these to compensate the collective of consumers.

5.80 In case of positive quality outcomes, i.e. when the supplied quality level exceeds the base level, we propose to simply charge the consumer collective in year 3. Of course, it would be possible to use a symmetric model where quality deviations below and above given thresholds are compensated and charged the individual consumers. We suggest however that individualizing below base level deviations is more important than individualizing above base level payments.

5.81 Carry-forward for year 1, including the negative or positive difference from the revenue yardstick and the pooled difference from the quality incentive scheme, is announced to the DSO for settlement year 3.

5.82 The DSO incorporates the Carry-forward for year 1 in the establishment of tariffs and a projected budget for year 3. The tariffs and the projected budget are submitted to the regulator for formal approval as an acknowledgement of the Carry-forward.

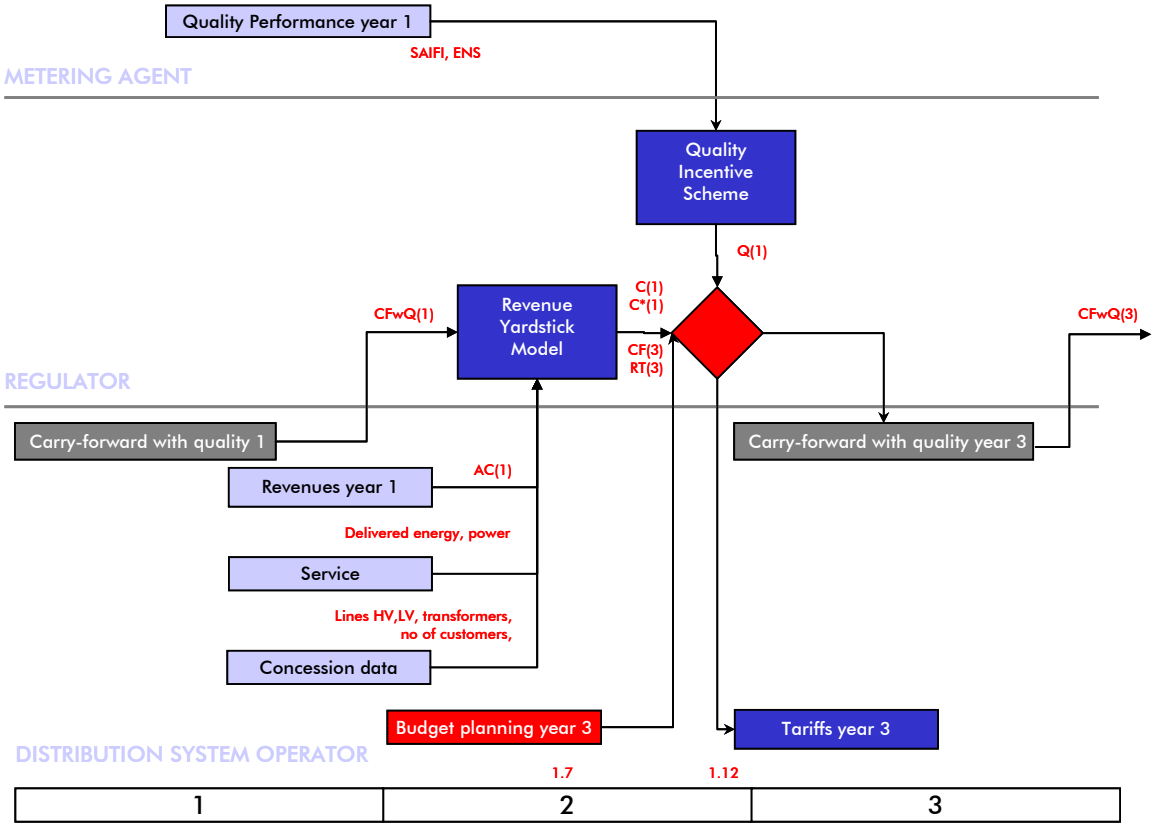

Figure 5-5 The NEMESYS regulatory procedure

Conclusion

5.83 The revenue yardstick model developed above is competitive, modern and fully output-based.

5.84 The yardstick model is founded on the virtues of yardstick competition, i.e. the DSOs can compete even though they do not meet directly at the market. This safeguards the consumers against too high tariffs and it safeguards the DSOs against unreasonable impact from regulatory interference based on limited information. The economic condition of one DSO is basically defined by the other DSOs, not by a regulator.

5.85 The yardstick idea is adjusted however to become practically implementable and to comply with EU principles. This is done by invoking a two year delay which enables 1) the DSOs to do their financial accounting in the usual way, 2) the regulator to have time to collect and process tariff and service data, and 3) the consumers to know tariffs a priori.

5.86 The model moreover avoids the difficult problems of capital valuation and basically leaves this to the DSOs and the capital market. The revenue yardstick model leverages the firm's need for financial stability (ex ante tariff delegation) with the regulator's mission to ensure efficiency (ex post yardstick correction). The incentive power (α and β) can be set to "tune" the regime to different capital risks.

5.87 The revenue yardstick regulation model also shares the general advantages of yardstick competition over CPI-X regulation. In particular, it is robust to technical developments and avoids the problem of leaving too low or too high rents to the DSOs.

5.88 The revenue yardstick model gives potentially high incentives for restructuring that may improve cost efficiency.

5.89 The quality incentive scheme supports the optimal trade-off between cost and benefits of security of supply. Moreover, it provides quality incentive for DSOs irrespectively of their performances in the revenue yardstick competition. That is, even inefficient DSOs are encouraged to care about security of supply.

6. Firm-level Impact Analysis

6.01 The revenue yardstick model and the quality incentive scheme have been evaluated with regards to consequences for the firms should these models be implemented as a joint Nordic regulation design. The two models are supplemental, and can be integrated to a larger or lesser extent. The consequence evaluation assumes that the two models are disintegrated.

6.02 Different aspects related to the incentives provided by the Revenue yardstick model and Quality incentive schemes from the firms' point of view have been evaluated on an overall basis, as well as across the dimensions size, nationality and ownership. The firm-level evaluation has been based on the aspects listed in 2.60 and include

1) Optimal allocation of decisions and information.
2) Incentives for sound industry structural changes.
3) Incentives for efficiency improvements.
4) Incentives for tariff reductions.
5) Incentives for customer oriented quality improvements.
6) Incentives for (re)investments (see Chapter 8 for detailed discussions).
7) Unbiased firm-level performance assessment.
8) Low administrative costs of regulation.

Optimal allocation of decisions and information

6.03 The revenue yardstick and quality incentive models both aim at providing overall incentives through an overall framework for the efficient revenue and wanted quality level. The regulator does not specify how the firms should be operated through the revenue yardstick and Quality incentive models. In other words, the firms are individually responsible for making day to day operational decisions that influence on their profits, while the regulator determines the overall limitations to this profit. This is, however, similar to what is currently the case in the four Nordic countries.

Incentives for sound industry structural changes

6.04 The characteristics of the revenue yardstick model, implying strong incentives for efficiency improvements, will provide incentives for industry structural changes. Firms achieving a low profit over longer time will eventually have to go through some structural changes. Owners pursuing a pure profit maximizing line will be interested in all measures that can contribute to improving the profitability, that being mergers and acquisitions, outsourcing etc. Owners pursuing several conflicting goals might eventually find themselves in a situation where the profit of the firm has been too low for a too long period of time, and might also be forced to structural changes.

6.05 Efficient firms will achieve a relatively high Rate of Return on their investments, at least as long as they remain efficient. This means that efficient firms might have an interest in buying inefficient firms in order to exploit the efficiency potential that has been revealed, and hence increase their own profit.

6.06 There should be no differences in consequences dependent on the nationality, as long as the efficiency model has been defined in an unbiased and fair way and the data are harmonized. Currently, the regulators of the different Nordic countries both collect different data, and apply different technical definitions to the data that are to be submitted by the companies. In order to avoid different consequences depending on nationality, some harmonization of the data to be collected, and the technical definitions, is important. This should be possible over a period of some years. Perfect harmonization facilitates but is not a pre-requisite, however, for fair benchmarking and relative performance evaluation. Differences in the data collected and definitions applied can also to some extent be compensated for by state-of-the-art benchmarking techniques. This is necessary also to cope with differences in "external data" , e.g. weather, that are needed to reflect different environmental conditions. There is always a risk that differences in the environmental conditions of the Nordic countries are not sufficiently taken care of, but a pan-Nordic effort with a larger sample and a joint effort will reduce this risk.. The data issue has been thoroughly discussed in NEMESYS (2005c).

Incentives for efficiency improvements

6.07 The incentives for *efficiency improvements* are strong with the revenue yardstick model. The yardstick revenue C*(y) for a given DSO does not depend on its own costs, only on the services it provides y and the performance of the other DSOs as reflected in the C* benchmarking model. Therefore, any efficiency improvements will generate a 1-1 increase in profits. This is similar to the incentives in the classical CPI-X scheme that has gained its popularity precisely from these strong incentives.

6.08 In the revenue yardstick model, there is an added advantage of efficiency improvements since it reduces the risk of having (sustainable) tariffs above the benchmark level and hereby the risk of having to pay the extra penalty rate δ.

6.09 In turn, this also means that the DSO has *strong incentives to reduce tariffs* and set these equal to the level which is sustainable in the long run, namely the actual minimal total costs (including capital costs). Truly, the DSO can chose tariffs above their minimal costs. This corresponds to the DSO taking a loan from the consumers. This loan however carries the same interest rate as the normal capital market and in addition there is a risk that it will carry the extra penalty δ.

6.10 The incentives for tariff- and cost reductions can be illustrated by way of an example.

6.11 The illustration of the revenue yardstick model incentives has been made for three firms. Fro simplicity, we assume that they all produce the same services. This means that the benchmarking reduces to a simple comparison with the minimal (benchmarked) charges of the other companies.

6.12 We assume that the interest rate is α=5% and that the penalty rate is δ=5%. Also, we assume that up until the start of period 1, all companies have charged 100 from the costumers in each period

6.13 The development in underlying minimal costs are illustrated in *italics* and the chosen DSO charges are illustrated in **bold** in the tables below.

6.14 In the first example illustrated in Table 6-1 below, we assume that there is some general development in the DSO costs that affects every DSO. The cost levels (including capital costs) in the periods 1-5 is 100, 90, 80, 90 and 100, and we assume that the companies simply charge these cost to the consumers, i.e. there is no attempt by anyone to make extra-ordinary profits for example from a sudden decrease in the costs.

Table 6-1 Revenue yardstick model example 1

		Period 1	Period 2	Period 3	Period 4	Period 5
DSO One						
Yardstick revenue	RB(t)=C*(t-2)	100	100	100	90	80
Carry-forward	CF(t)	0	0	0	0	0
Total costs	c(t)	*100*	*90*	*80*	*90*	*100*
Actual charges	AC(t)	**100**	**90**	**80**	**90**	**100**
Benchmarked charges	BC(t)=C(t)=AC(t)-CF(t)	100	90	80	90	100
Extraordinary Profit	AC(t)-c(t)	0	0	0	0	0
DSO Two						
Yardstick revenue	C*(t-2)	100	100	100	90	80
Carry-forward	CF(t)	0	0	0	0	0
Total costs	c(t)	*100*	*90*	*80*	*90*	*100*
Actual charges	AC(t)	**100**	**90**	**80**	**90**	**100**
Benchmarked charges	BC(t)=C(t)=AC(t)-CF(t)	100	90	80	90	100
Extraordinary Profit	AC(t)-c(t)	0	0	0	0	0
DSO Three						
Yardstick revenue	C*(t-2)	100	100	100	90	80
Carry-forward	CF(t)	0	0	0	0	0
Total costs	c(t)	*100*	*90*	*80*	*90*	*100*
Actual charges	AC(t)	**100**	**90**	**80**	**90**	**100**
Benchmarked charges	BC(t)=C(t)=AC(t)-CF(t)	100	90	80	90	100
Extraordinary Profit	AC(t)-c(t)	0	0	0	0	0

6.15 The example shows how an initially non-predictable but common industry wide development of the DSO costs does not lead to neither extra-ordinary period by period profits nor losses that would have resulted from a fixed X factor in a traditional CPI-X ex ante regulation.

6.16 In our next example in Table 6-2 we assume that DSO is now subject to some idiosyncratic extra costs in Period 2.

Table 6-2 Revenue yardstick model example 2

		Period 1	Period 2	Period 3	Period 4	Period 5
DSO One						
Yardstick revenue	RB(t)=C*(t-2)	100	100	100	90	90
Carry-forward	CF(t)	0	0	0	0	0
Total costs	c(t)	*100*	*90*	*90*	*90*	*90*
Actual charges	AC(t)	**100**	**90**	**90**	**90**	**90**
Benchmarked charges	BC(t)=C(t)=AC(t)-CF(t)	100	90	90	90	90
Extraordinary Profit	AC(t)-c(t)	0	0	0	0	0
DSO Two						
Yardstick revenue	C*(t-2)	100	100	100	90	90
Carry-forward	CF(t)	0	0	0	-11.5	0
Total costs	c(t)	*100*	*100*	*90*	*90*	*90*
Actual charges	AC(t)	**100**	**100**	**90**	**78.5**	**90**
Benchmarked charges	BC(t)=C(t)=AC(t)-CF(t)	100	100	90	90	90
Extraordinary Profit	AC(t)-c(t)	0	0	0	-11.5	0
DSO Three						
Yardstick revenue	C*(t-2)	100	100	100	90	90
Carry-forward	CF(t)	0	0	0	0	0
Total costs	c(t)	*100*	*90*	*90*	*90*	*90*
Actual charges	AC(t)	**100**	**90**	**90**	**90**	**90**
Benchmarked charges	BC(t)=C(t)=AC(t)-CF(t)	100	90	90	90	90
Extraordinary Profit	AC(t)-c(t)	0	0	0	0	0

6.17 The example shows the effect if the DSO Two initially tries to pass on the idiosyncratic cost increases to the consumers. It creates a negative carry forward that it will the have to repay to the consumers in Period 4. In Periods 6 and onwards the carry forward in 0 for all DSO if nothing else happens. The example shows how idiosyncratic variations in the costs will bee carried by the individual DSOs.

6.18 In our final example illustrated in Table 6-3 the cost develops like I the previous example, but DSO Three decides to not reduce charges following the reduction in costs. This leads to an immediate extraordinary profit of 10, but it has to be re-paid in period 4 with the extra costs from having over-charged in period 2.

Table 6-3 Revenue yardstick model example 3

		Period 1	Period 2	Period 3	Period 4	Period 5
DSO One						
Yardstick revenue	RB(t)=C*(t-2)	100	100	100	100	90
Carry-forward	CF(t)	0	0	0	10.5	0
Total costs	c(t)	*100*	*90*	*90*	*90*	*90*
Actual charges	AC(t)	**100**	**90**	**90**	**100.5**	**90**
Benchmarked charges	BC(t)=C(t)=AC(t)-CF(t)	100	90	90	90	90
Extraordinary Profit	AC(t)-c(t)	0	0	0	10.5	0
DSO Two						
Yardstick revenue	C*(t-2)	100	100	100	90	90
Carry-forward	CF(t)	0	0	0	-11.5	0
Total costs	c(t)	*100*	*100*	*90*	*90*	*90*
Actual charges	AC(t)	**100**	**100**	**90**	**78.5**	**90**
Benchmarked charges	BC(t)=C(t)=AC(t)-CF(t)	100	100	90	90	90
Extraordinary Profit	AC(t)-c(t)	0	0	0	-11.5	0
DSO Three						
Yardstick revenue	C*(t-2)	100	100	100	90	90
Carry-forward	CF(t)	0	0	0	-11.5	0
Total costs	c(t)	*100*	*90*	*90*	*90*	*90*
Actual charges	AC(t)	**100**	**100**	**90**	**78.5**	**90**
Benchmarked charges	BC(t)=C(t)=AC(t)-CF(t)	100	100	90	90	90
Extraordinary Profit	AC(t)-c(t)	0	10	0	-11.5	0

6.19 The examples show that:

1) The yardstick model provides strong incentives for efficiency improvements as the impacts of cost reductions on profit can be kept entirely by the companies.
2) The yardstick model rewards efficient companies with a higher profit.
3) The yardstick model provides incentives for efficient firms to reduce charges by the super-efficiency mechanism.
4) Inefficient companies are eventually forced to reduce their tariffs to the level of efficient tariff revenues.
5) The companies are protected against industry variations in costs
6) The companies carries the cost (and gains) from idiosyncratic variations in costs
7)

6.20 Ownership and size may impact the extent to which the firms can and will respond to these incentives through cost cutting measures. Small distribution companies, of which there are many in the Nordic electricity market, might not be able to reduce their operations to the "optimal size". Explanations for this can be that they might have to employ a person 100 % although they need only 80 % and that they need to install systems which basically cost the same independent of size (e.g. customer information systems).

6.21 The counter-argument is that smaller companies can reduce their size through outsourcing, strategic alliances and mergers. However, this might particularly be perceived as problematic for small firms with local, public ownership. Public owners often pursue several, at times conflicting, goals such as local employment, low tariffs and high profit. Owners of smaller firms pursuing local employment as an important goal might have to accept a lower Rate of Return with the revenue yardstick model.

6.22 The consequences of the revenue yardstick model for small firms compared to large firms, for firms from one country compared to another country and for firms with public compared to private ownership should not differ if the determination of the efficient revenue is done in an unbiased and fair way. This means that the efficiency model being used has to be neutral with regards to size, nationality, operational conditions etc. If there is a small scale disadvantage, for example, a model with non decreasing return to scale properties shall be estimated, cf. also NEMESYS(2005c).

6.23 The quality incentive model also provides incentives for efficiency improvements. However, the strengths of the incentives will depend on the design of the quality incentive scheme. Since the quality incentive scheme implies different costs depending on the time period and the customer type affected by the interruptions, the firms can achieve higher profit by prioritizing the most expensive customers first and by avoiding expensive time periods for e.g., maintenance.

Incentives for tariff reductions

6.24 The revenue yardstick model is based on actual tariff revenues from year t-2 for determining the efficient revenues (set by the efficiency model). Higher actual tariff revenues will reduce the efficiency scores and lower actual tariff revenues will increase the efficiency scores. As was argued above and as can be seen from the examples, inefficient companies in particular are given incentives to tariff reductions through the revenue yardstick model. The risk of ending up as inefficient might give incentives for tariff reductions by efficient and super-efficient companies.

6.25 In order to achieve improvements of the efficiency scores, the tariffs relative to the comparator(s) have to be reduced. This can lead to price competition between the firms, which would in turn reduce the tariffs for the customers.

6.26 To some extent local price competition already exists for many grid companies, where the tariffs of the neighboring firms are used as a guideline for determining the firm's own tariffs. This might particularly be the case for small firms with local public owners. For small communities it is particularly important to attract population and businesses, among other things to secure tax revenues. The neighboring communities are the competitors, and the grid tariffs are often used as a "carrot" in that respect. Technically, the revenue yardstick model could change the companies to which a particular grid company is compared. Assuming that the efficiency model sufficiently handles different operational conditions, the group of companies to which a company is compared might be located far away and not include any of the neighboring firms. However, firms including price comparisons in determining their tariffs are more likely to continue to compare its

own tariffs towards the neighboring companies also with the revenue yardstick model, since its customers are more likely to do local price comparisons. However, the additional efficiency incentives provided by the revenue yardstick model might enforce the price competition.

6.27 Furthermore, the tariffs of several areas are still politically determined rather than based on financial evaluations. This might imply that a politically determined tariff determines the efficient revenues for other firms, leading to an unrealistically low level of efficient revenues for the industry. This has been discussed in detail in a later section of this chapter.

6.28 A consequence of the revenue yardstick model based on actual tariff revenues for determining the efficient revenue might be that the efficient revenues never will go below the initially defined level of efficient revenues. Using the actual tariff revenues in determining the efficient revenues can, however, imply more stable tariffs for the customers as compared to using the costs. The costs vary over the years, and the firm(s) with the relatively lowest cost at any time will determine the efficient costs. Unless there actually exists a fierce price competition as a consequence of the regulation, the tariffs might stabilize on a certain, by the firms and customers acceptable, level. This level might be somewhat independent of the costs of the different firms at all times.

6.29 Through base-level quality costs are defined to which the actual quality costs (incremental ENS costs) are referred. When the firm achieves actual quality costs higher than the base-level costs, the tariffs can be increased accordingly in subsequent years. If, however, the firm under-performs on the quality level the tariffs have to be reduced accordingly in order to "compensate" the customers for inferior quality. This means that the customers face tariff reductions in case of a below-standard quality level.

6.30 As long as the base-level quality costs and the pro-rata (marginal price) quality costs are determined in an unbiased and unified way across the dimensions, there will be no differences in firm-level consequences depending on size, nationality and ownership. An important challenge for the time being, however, is the access to data that can form the basis for determining the base-level quality costs. This requires both information about quality benefits and quality costs. The former necessitates studies of consumers and will to a large extent be specific to the country and region. The latter, however, involves analyses of DSO costs, and such analyses may be handicapped by non-harmonized definitions and measures in the different countries, cf. (NEMESYS, 2005c).

Incentives for customer oriented quality improvements

6.31 The revenue yardstick model regulation, as all other regulatory regimes designed to promote efficiency improvements, might lead to reduced quality for the customers unless there is some kind of quality regulation in place. The reason for this is that fierce costs cutting related to maintenance and investments might lead to lower quality in a longer term. Therefore it is important to supplement the revenue yardstick model with some kind of quality regulation like the quality incentive scheme.

6.32 The firm consequences of the quality incentive scheme with regard to customer oriented quality improvements will depend on whether or not the base-level

quality costs are determined somewhat correctly, and that the incremental ENS costs represent the true costs for the customers. Figure 6-1 illustrates the quality incentive scheme for a firm with base-level quality costs set at a reasonable level relatively to the technical and operational situation.

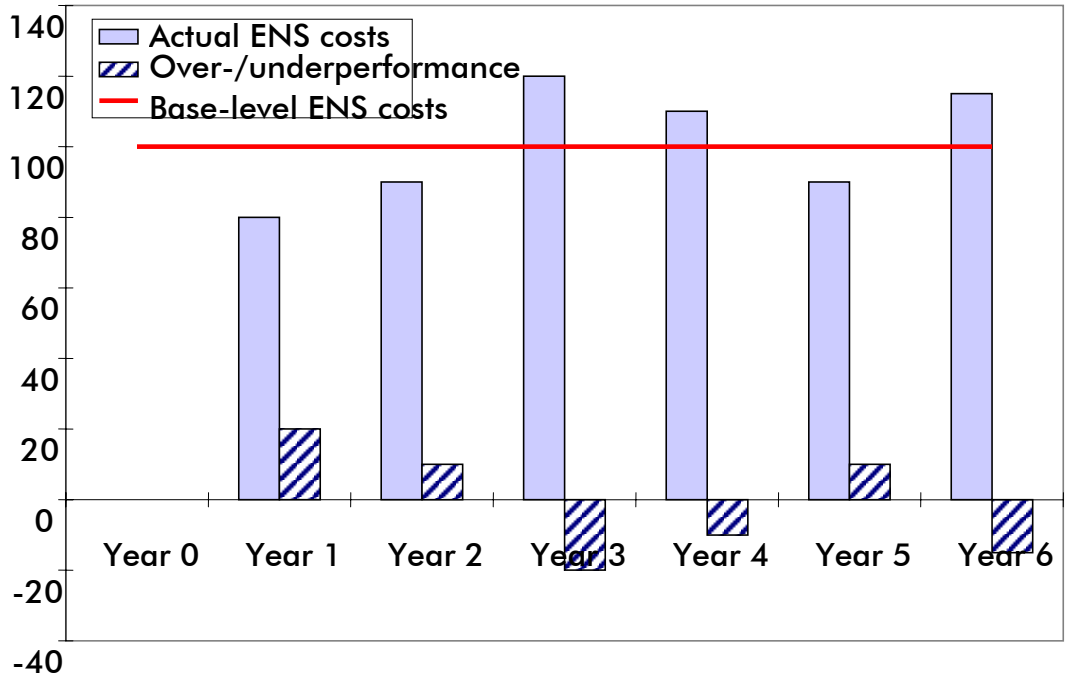

Figure 6-1 Illustration of the quality incentive model.

6.33 The firm illustrated by Figure 6-1 delivers a higher quality than the base-level quality costs in the years 1, 2 and 5, and a lower quality in the years 3, 4 and 6. The over-performance in the years 1, 2 and 5 can be charged the customers, while the under-performance in the years 3, 4 and 6 has to be compensated to the customers.

6.34 Through actions improving the quality that the customers experience, for instance actions reducing ENS and the number of interruptions, the actual quality costs (incremental ENS costs) might be reduced. This will increase the accumulated over performance that can be charged the customers through higher rates and hence increase the firms' profit.

6.35 If, however, the pro-rata quality costs (marginal prices) are defined at a lower level than what is the true level, the firm will not carry through all customer oriented quality improvement actions that are profitable from a societal perspective. Likewise, if the pro-rata quality costs are defined at a higher level than what is the true level, the firm will carry through too many customer oriented quality improvement actions than what is profitable from a societal perspective.

6.36 Furthermore, if the base-level quality costs (based on an independent technical review) are set too high, the firm would gain unreasonable windfall profit through too high tariffs, which might reduce the incentives to promoting customer oriented quality improvements. Likewise, if the base-level quality costs are set too low, the firm would be unreasonably punished.

6.37 Smaller companies with local public owners might to a lesser extent than larger companies be influenced by the quality regulation. Local employment might be a stronger driving force for a continuously higher level of maintenance and investments for small firms than the quality incentives. However, this would also imply that the owners have chosen not to pursue all existing efficiency improvement potentials, and will consequently have to accept a lower profit than what could otherwise be possible.

Unbiased firm-level performance assessment

6.38 The allowed revenues with the revenue yardstick model will have to be determined on unbiased criteria that are well defined in advance. The most critical element of the model is without doubt the determination of the efficient revenues. The efficiency model being used has to be unbiased without discriminating with regards to size, nationality, ownership, operational conditions etc.

Low administrative costs of regulation

6.39 The level of administrative costs for the firms will be influenced by the regulatory design. The revenue yardstick and quality incentive models will imply administrative costs related to detailed reporting of a set of technical and financial data. The level of details of the reporting will not, however, be very different from what is currently the case in the Nordic countries. There might, however, be some initial cost increases related to data harmonization.

6.40 In order to be able to budget future revenues and plan future investments, it is necessary for the firms to have a decent understanding of the existing regulatory model at all times. For some companies, particularly smaller firms, it might be a challenge to understand the revenue yardstick model, specially the method for determining the efficient revenues. Understanding the existing efficiency models is currently also problematic for many companies, but the rather frequent regulatory reviews assumed by the revenue yardstick model increases the uncertainty related to the efficiency scores for the firms. Assigning staff, or purchasing external assistance, to take care of regulatory issues and estimating future revenues might both lead to increased administrative costs. Observe however that the more frequent adjustments also carry the advantage that the long term impact of a misreporting or misunderstanding is smaller than in a traditional CPI-X regime. This may help to reduce the administrative burdens.

6.41 The administrative costs for the firms related to the quality incentive model will depend on the degree of integration with the revenue yardstick model. A highly disintegrated quality incentive model will imply some administrative costs related to management and reporting of under and over performance relative to the quality status quo. This might not be necessary with a higher integration of the quality incentive model. However, these costs are not expected to be high.

The proposal in practice

Implementation requires harmonization

6.42 In practice, the design of the efficiency model and level of the α and β are essential elements for the objectivity and incentives of the revenue yardstick model. The efficiency model has to be unbiased with regards to size, nationality, location, operational conditions etc. in order to be fair. Furthermore, the regulated grid functions of the Nordic countries have to be comparable, which might require harmonization of grid activities defined as monopoly activities and reporting structure. Harmonization of which data are collected, and how they are defined, is also required.

6.43 As shown in NEMESYS (2005c), differences in tasks and data definitions are currently problematic across the Nordic countries, and will probably cause national differences should the revenue yardstick model and the quality incentive scheme be introduced based on the current data reporting systems. This can also be seen from the efficiency calculations. Although companies from all countries contribute to defining the efficient front, the share of efficient companies in each country varies rather much. This may reflect that the incumbent regulations are not equally effective. It may also reflect that the data used in the calculations do not allow an entirely neutral modelling, and that the efficiency model needs to be more sophisticated than the rather simple models used in the illustrative calculations.

6.44 Both large and small firms have been found efficient in the regulators' as well as the NEMESYS efficiency calculations (NEMESYS, 2005c). However, the NEMESYS calculations show that the mid-size companies are closer to operating on an efficient scale than small and large companies.

6.45 In a study for the Norwegian Electricity Industry Association (ECGroup AS, 2005) there seems to be a connection between measured efficiency, size, the age structure of the grid as well as the operational difficulty of the Norwegian firms. The smallest companies appear to be the least efficient, have the oldest grid and be located in the most sparsely populated areas.

6.46 This general picture might be a true one. However, it might also indicate that the efficiency model being used is biased. However, assuming a hypothesis that small companies located in sparsely populated areas are less efficient than other groups of grid companies, the implications could be:

1) The pressure for efficiency improvements is strongest for these types of companies. However, as discussed earlier, local public owners of small firms might accept lower profit in order to maintain employment.
2) If the above described trend is maintained when actual tariff revenues is used in the efficiency studies rather than costs, the pressure for tariff reductions will be the largest for these companies. However, aspects of local price competition might influence on this.
3) Industry structure changes will most likely include these types of companies. However, both ownership and geography might play a role in this aspect. Some owners are unwilling to structural changes, and some firms are located in such areas that it is difficult to exploit the measured inefficiency (e.g. islands).

4) External funding might be more difficult to achieve. However, local public owners with local employment high on the agenda might be willing to provide funding if needed.

Impact of non-profit strategies

6.47 This subchapter provides an in-depth analysis related to DSOs with non-profit ownership structures, in particular cooperatives and municipal utilities. The analysis is based on theoretical discussion and it is supported by empirical data. The analysis aims at determining the projected behavior of different types of firms under the suggested regulatory mechanism and the impact this may have on other firms. In particular, we aim at describing the decision making and the operational objectives of the firms.

6.48 The main concern here is that there are not-for-profit DSOs that affect the efficient revenue level of other, for profit companies in the dataset. If there really are these kinds of companies in the dataset, it causes potential problems in the revenue yardstick model as the efficient revenue level is lower than that of an efficient company that wants to make profit.

6.49 We first discuss possible strategies related to profit and cost. From a theoretical point of view we can identify possible tariff and cost strategies. Three cost components are important in the analysis: 1) operational expenses, 2) cost of equity and 3) interest paid for debt. We start with a simplified model and assume that revenue = operational expenditure + depreciation + capital cost related to debt + profit. Here profit equals the return on equity, i.e. capital cost of equity. Given the current capital structure of a company, the depreciation and capital cost of debt are practically independent of the profit or cost level. Hence the company has two parameters it can affect, i.e. revenue and operational costs. In this simplified model this means that profit = revenue – operational expenditure – a constant.

6.50 We can assume that the interest rate of debt is practically independent of the chosen strategy. The lower cost of equity may also have a secondary effect on the capital costs though the tendency to increase the equity to debt ratio, which will at the same time decrease the amount of debt and the risk premium related to interest rate of debt. However this effect is clearly smaller than the direct impacts, and hence this aspect is not discussed further here.

6.51 As the yardstick model is based on revenue, it is important to identify different types of strategies related to the two cost components. The following three simplified strategies serve as benchmarks in the theoretical analysis.

1) The company is profit maximizer (max. return on equity), i.e. it minimizes costs and tries to maximize the revenue (in given limits). This is the classical strategy of a private company, and a majority of companies in a market economy are expected to behave according to this strategy.
2) The company is cost minimizer, but has a non-profit strategy. In practice this means minimizing the revenue so that the costs will be covered. In this case the (explicit) return on equity is (close to) zero. The reasoning behind this may be co-operative ownership structure (i.e. return on equity is included on the tariffs), municipal policy (i.e. subsidy for local business) etc.

3) The company has a non-profit strategy, but it is not a cost minimizer. In this case the value added is distributed to employees, subcontractors etc. in the form of higher than efficient cost level. The rationale behind this might be local employment policy etc, but the behavior might also be unconscious and caused by the unwillingness to downsize the organization etc.

6.52 As there is a separate compensation scheme for quality, different strategies related to quality levels are not discussed in connection with the cost and revenue levels.

6.53 In the following paragraphs we discuss the theoretical consequences of these strategies on the suggested regulatory model. We analyze both the effect on the company itself, and the effect on the other companies in the dataset.

6.54 The profit maximizing company aims at minimizing costs and maximizing revenue. The main idea of the suggested regulation model is to maintain the natural tendency for cost minimization, and at the same time give incentives to lower tariffs.

6.55 When we consider the second strategy where company tries to minimize the tariffs, the objective of the company is not in conflict with the objectives of the customers or the regulator. Hence, if the company is successfully implementing this strategy, the suggested model does not provide any direct incentives. In this case the company has an internal goal of pushing the revenue level below the reference level by both cutting the costs and avoiding making profit. Hence this kind of company would push the revenue level as far as it is able to cover efficient operational costs, depreciation and possible capital costs related to debt. If these companies are allowed to act as peers for the for-profit companies, the profit levels would tend to be pushed towards zero.

6.56 When we look at the third strategy, where the company is neither a cost minimizer nor a profit maximizer, we see that the total acceptable revenue would be set by the model. Hence the customers would face the same tariff level as for the profit maximizing company. There is a pressure for cost reductions up to the level where the cost inefficiency would equal the profit of the cost efficient companies.

6.57 From this theoretical discussion we see that there is a potential conflict of interest between the cost minimizing companies with for-profit and not-for-profit strategies. While the cost level of these companies equals (given equal environment), the not-for-profit company would set its revenue lower. In the revenue based DEA model this would lead to a situation where the frontier is based on the efficient cost level, with no profit. This means that the profit maximizing company would not be allowed to make profit. The implications of different strategies in the revenue yardstick system are summarized in Table 6-4.

Table 6-4 Implications of different profit strategies in the revenue yardstick system

	Strategy 1 Profit maximization	Strategy 2 Tariff minimization	Strategy 3 Operational slack
Impact of the yardstick model on firm level short run surplus	Increased profit for efficient firms, decreased for inefficient firms	No impact	Limits the operational slack to the level of the profit of efficient firms
Impact of the yardstick model on firm level long run surplus	Positive through incentives for cost efficiency	No direct impact, transfer of best practice may allow further tariff cuts	Limits the operational slack to the level of the profit of efficient firms
Impact of the firm on the yardstick	Defines the true best practice	Reflect best practice revenue level that does not cover true capital costs	No impact
Impact of the firm on industry short run profit	Due to the efficiency differences the profits will be decreased until the efficiency level increases	Increase the efficiency differences and further decrease the profit level	No impact
Impact of the firm on Industry long run profit	In the equilibrium the total profit would increase and be stabilized	In the long run push the industry towards zero profit	No impact

6.58 In practice the key question is if the strategies of the companies really differ in practice so that is has an impact on the revenue level. It is evident that ownership structure or legal status of the company does not reveal the underlying strategy. For examples municipal utilities might choose strategy 1 so that the profits can be used for decreasing the level of municipal taxes. On the other hand some privately owned companies might show social responsibility and choose a mixed strategy. Furthermore a not-for-profit company, e.g. a co-operative, may have chosen either cost minimizing strategy where the value added is channeled to the customers in the form of lower tariffs, or a strategy with higher cost level where value added is channeled to employees, subcontractors etc or to the customers in the form of extra services. Hence the organizational structure or the ownership does not directly reveal the strategy.

6.59 The practical possibilities for executing a non-profit strategy are also limited by the availability of zero-interest capital. There are various sources of this kind of capital. Finnish DSOs have e.g. financed investments partly by connection fees. Also positive cash flow from previous years may serve as a source of equity. In some cases the owners, especially municipal, may be willing to accept return that is lower than the market cost of capital indicates. These sources can then be complemented with loans etc. Hence, the history of the DSO has important impacts on the capital structure.

6.60 In case of Finland, we can analyze the situation by comparing the profit and the cost efficiency of the companies. However, information on the ownership structure is not directly available and furthermore it would be very difficult to identify the

cost and profit strategies of the companies. Hence we base the analysis on the straight forward comparison of cost-efficiency and profit (before taxes, etc.) as percentage of revenue. Figure 6-2 presents the results. We can notice that 9% of the companies are very cost efficient (>0.9) and still do not make significant profit (<5%). This corresponds to the shaded are in the figure. These companies include municipal DSOs, co-operatives and companies. Also the statements presented by the managers of certain DSOs suggest that some companies really try to execute tariff minimizing strategy. This evidence supports the view that there are some, although few, non-profit companies in the dataset that may end up at the revenue efficiency frontier. However, we need to keep in mind that the analysis does not take into account the differences in the capital structure of the companies.

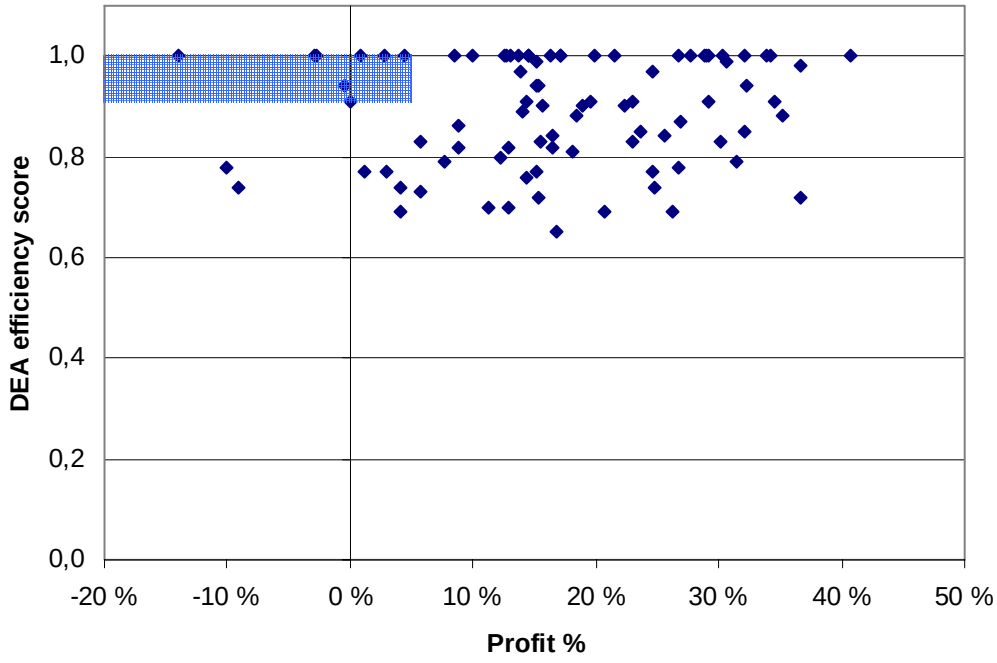

Figure 6-2 The connection of cost efficiency and profit (before taxes as a percentage of revenus) in Finland (Source: EMV DEA resutls and economic indicators 2003)

6.61 Empirical evidence from Sweden suggests that there is no systematic difference in the total cost (revenue) of companies with different ownership structures. Preliminary analysis based on publicly available data indicates that the revenue efficiency of the private companies is on average higher than that of municipal or co-operative companies. This seems to be caused by the clear differences in the average short run cost efficiencies. Unlike in Finland none of the of the short run cost efficient firms operate with zero profit. This means that the potentially lower cost of equity of the municipal DSOs seems to be more than compensated by the lower operational efficiency. The few exceptions to this pattern are some cooperative DSOs that succeed in keeping both low operating costs and low capital costs. However, further studies are necessary to determine whether these observations are related to a specific investment cycle or other specific circumstances.

6.62 The revenue cap regulation has a tendency to even out the differences between the companies and hence Norwegian and Danish data would be less suitable for analyzing the differences in the company strategies. However, Danish experiences from the revenue cap model in 2000-2003 show that many companies did not use the allowed revenue cap. This suggests that some of the companies have adopted a non-profit strategy with efficient cost level.

6.63 Based on the material collected and discussions during the project, the biggest concerns seem to be related to Danish co-operatives, and some Finnish municipal companies that have selected a non-profit strategy. Although the effect is not necessarily as big as the concerns indicate, the empirical data indicates that there are some companies that have adopted tariff minimizing strategy and this has a potential effect on the yardstick revenues. However, the real significance of this effect is unclear. For example, there are also other, competitive industries like retail and insurance sectors, where co-operative non-profit companies compete with for profit companies, and this is not seen as a problem.

Conclusion

6.64 Table 6-5 below sums up the above analysis through a list of advantages and disadvantages from the firm's perspective. The dimensions firm size, nationality and ownership have also been discussed.

Table 6-5. Advantages and disadvantages from the firm perspective

	Firm perspective		Different consequences dependent on		
	Advantages	**Disadvantages**	**Size**	**Nationality**	**Ownership**
Optimal allocation of decisions and information	No micro management by the regulator		Should not be the case	Dependent on other regulations	Should not be the case
Incentives for sound industry structural changes	Strong incentives for increased profits through structural changes	Inefficient companies might be "forced" to mergers and aquisitions	Smaller companies might be more exposed to structural changes	Different national rules for national and Pan-Nordic mergers and aquisitions?	Local public owners might be hesitant to structural changes
Incentives for efficiency improvements	Efficient companies and efficiency improvements are rewarded	Inefficient companies might earn very low profits	Should not be the case with a fair efficiency model	Harmonization of data is required	Public owners with conflicting goals might not pursue efficiency improvements - lower profits
Incentives for tariff reductions	Tariff revenues as input - more stable tariffs?	Fierce price competition might reduce profits	Should not be the case	Should not be the case	Public owners - already lower tariffs through politically determined tariffs?
Incentives for customer oriented quality implications	Quality improvements increase profits	Might be hard to get the status quo level and the quality costs right	Should not be the case	Should not be the case with "correct" quality costs and status quo levels	Should not be the case
Unbiased firm-level performance assessment	Unified and well defined criterias	The design of the efficiency model is essential with regards to fairness	The efficiency model should not discriminate with regards to size	The efficiency model should not discriminate with regards to nationality	The efficiency model should not discriminate with regards to ownership
Low administrative costs of regulation	Generally low probability for higher adm costs than today		Smaller companies might get increased adm costs due to the regulatory frequency	Only for a transitional phase	Should not be the case

6.65 The analysis of the firm consequences shows that the design of the efficiency model and harmonization of data are essential in the revenue yardstick model. Likewise the quality incentive scheme base level and marginal costs have to be "correctly" determined in order to achieve the wanted effects.

6.66 The revenue yardstick model will be advantageous for efficient companies, but will lead to low allowed profits for inefficient firms. In other words, efficient companies are awarded and efficiency improvements should pay off.

6.67 Ownership and size might influence on whether or not the firm responds to the incentives given by the revenue yardstick and quality incentive models. Some small firms with local public owners might pursue other goals than profit maximizing. These companies will be given low profit by the revenue yardstick model.

6.68 The levels of α and β influence the incentives given by the revenue yardstick model. A high α is beneficial for efficient companies while a low β is beneficial for inefficient companies.

6.69 Based on the analysis of different profit strategies, we can see that the suggested mechanism affects these in slightly different ways and the different strategies have different implications on the consequences of the mechanism. Companies with cost minimizing non-profit strategies play a key role here.

6.70 Yardstick competition between profit maximizing companies will in the short run lead to decreased profits, as inefficient companies would not be able to make profit. The differences would even out when the companies have adjusted their operations to the new situation. However the pressure on efficient units would be moderate. Non-profit cost minimizing companies would add a clear pressure by pushing the yardstick frontier towards zero profit level. However the mechanism does not provide incentives for doing this. The non-profit companies with operational slack would not have an impact on the frontier, but they would be forced to limit the slack to the level of the profit of the efficient companies.

6.71 Empirical data from Finland and Sweden provide mixed evidence on the actual existence of non-profit cost minimizing companies. Anyhow the number of these companies seems to be very limited, and excluding companies that make loss from the yardstick reference set would further decrease the impact. However the true effect of the different profit strategies is dependent on the parameters of the model and further analysis would be needed for drawing the final conclusions.

7. Policy-level Analysis

7.01 This chapter analyses the suggested regulation model from the stakeholder point of view. This chapter covers the wider societal dimension of the analysis, while company and investor perspective is analyzed in chapters 6 and 8. The purpose of this chapter is to discuss the advantages and disadvantages of the suggested regulation model compared to the current regulation models in the four countries. The purpose is to analyze the feasibility and acceptability of the suggested model. It is clear that the suggested model should provide clear advantages compared to the status quo situation.

7.02 The analysis presented above motivates the suggested model theoretically and shows that is in line with the regulation theory. This chapter concentrates on the practical feasibility for the stakeholders, especially clients and regulators.

7.03 The feasibility analysis is to large extent based on the finding in subproject A that analyzed the goals and objectives of different stakeholders and described the current regulatory systems adopted in the four countries (NEMESYS 2005a). This subsection provides a summary of the conclusions in sub project A. Sub project A collected structured data on the goals and objectives of different stakeholders in the four countries.

7.04 These goals and objectives provide a basis for the analysis of the advantages and disadvantages of the suggested model. As it is very difficult to analyze the feasibility of a model in absolute terms, the suggested model is compared to the current regulation model in each country. Here the analysis of the incentives and impact of the current models, which is presented in detail in NEMESYS (2005a), serves as a basis.

Stakeholder objectives and goals

7.05 The analysis of stakeholder goals and objectives identified four main categories or dimensions that are related to regulation. These are Economic Aspects, Quality, Equity and Fairness, and Social and Environmental Aspects. In addition we identified two more technical categories Implementation of the Regulation, and Technological Aspects. Each of the categories included a number of aspects. These are the following.

7.06 Economic aspects

1) Tariffs
2) Costs and efficiency
3) Profit
4) Return on investment

7.07 Quality

1) Security of supply (interruptions)
2) Quality of supply (voltage level etc.)
3) Customer service (invoicing, advising, information)

4) Additional products and services

7.08 Equity and fairness

1) Equality of different types of customers
2) Geographic equality
3) Equality of different distribution companies
4) Access to networks and markets (both consumers and producers)

7.09 Social and environmental aspects

1) Safety
2) Environmental effects
3) Land use planning
4) Aesthetics
5) Employment
6) Competitiveness of the country and the industry

7.10 The following paragraphs summarize the critical success factors of a pan-Nordic regulation model and present the key results of the stakeholder survey and interview material.

Importance of the groups of aspects

7.11 The results clearly show that economic issues, together with quality, are the most important groups of aspects. Hence, it is important both as a common objective and as a potential natural source of conflict between stakeholders. The current regulation models do not put high emphasis on the quality issues, but the results suggest that the importance is rising. On the other hand equality and fairness, and social and environmental issues are important, but these are more characteristics of a good regulatory system than goals that any stakeholder groups would see primary. Figure 7-1 presents the relative importance of the four groups of aspects by stakeholder group.

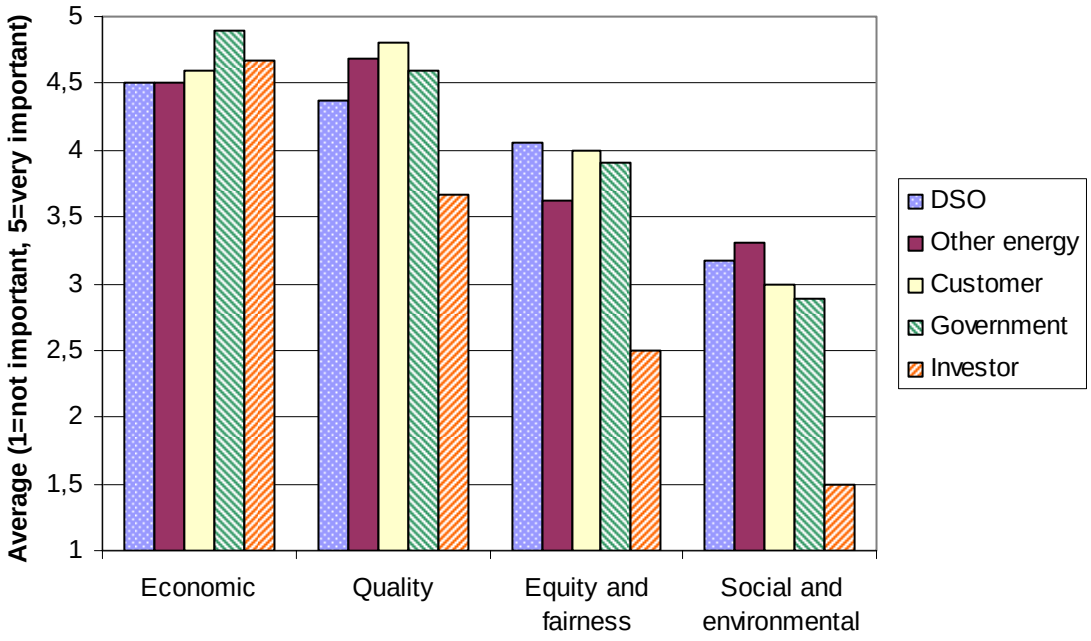

Figure 7-1 Relative importance of the four groups of aspects in a well functioning regulation system.

Economic issues

7.12 In the group of economic issues, stability is in general emphasized as an important part of a well functioning regulation system. Especially stability of tariffs is one area where the groups are unanimous. Figure 7-2 summarizes the results from the survey and the interviews.

7.13 Potential conflicts are related primarily to the level of tariffs and profits. The conflict arises from the fundamentally different interests of the stakeholder groups. Among the stakeholders, low ROI is most important and stable ROI least important for the authorities. Although the regulators and other authorities put a lot of emphasis on low tariffs and low profits, there is reluctance to accept bankruptcy as a potential consequence. A clear concern is that regulators do not recognize the DSOs' need for being competitive in the capital market.

7.14 In general, the opinions of the regulators and other authorities seem to be closer to the opinions of the customers than other groups. The results suggest that DSOs try to balance between the conflicting objectives of the other stakeholder groups.

7.15 The written comments, however, emphasize the importance of right balance especially between economic and quality issues. This is clear challenge for the regulation systems that should be able to balance the economic inputs and less tangible outputs related to quality aspects.

7.16 The opinions are largely shared in the Nordic countries, but there are some small differences in orientation between the countries. For example, in Denmark, less

emphasis is put on low tariffs and high profits, and Norwegians emphasize the correct level of tariffs, rather than low. There may also be conflicts between the countries in setting the political agenda and not just between the stakeholder groups.

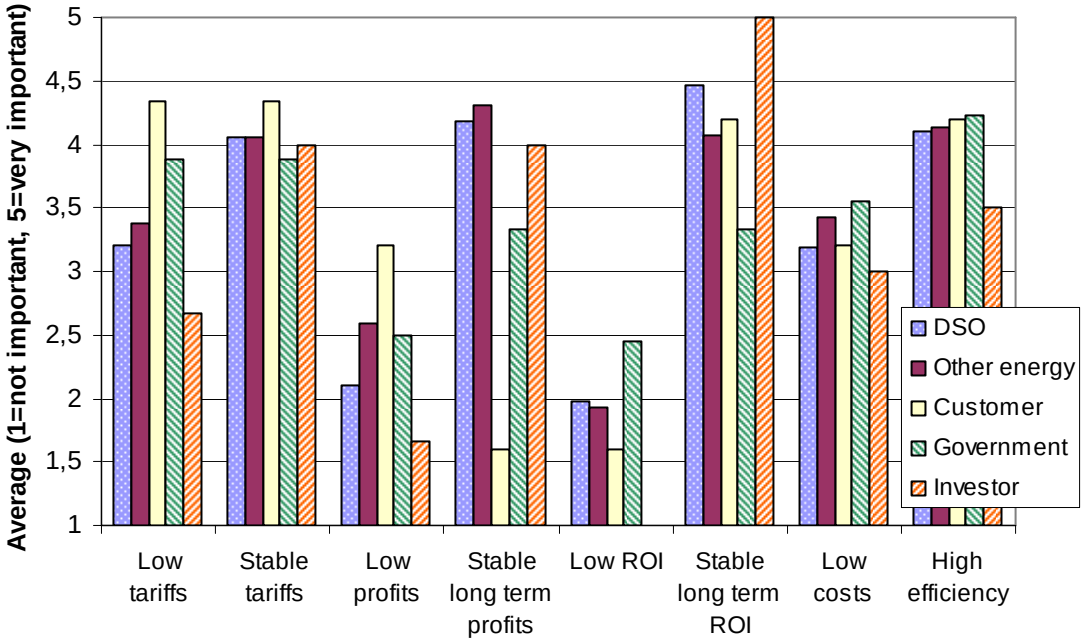

Figure 7-2 Relative importance of economic aspects in a well functioning regulation system

Quality

7.17 Quality in general is an important dimension in regulation for everybody and security of supply is even more important than any of the economic aspect. Thus quality is, per se, not a source of conflict. However, there is a clear link between the quality and the economic aspects. Consequently, the conflict in the quality issues would most likely be reflected in the economic issues. Figure 7-3 presents a summary of the results.

7.18 Although customer service has been emphasized in the discussions e.g. in Finland during the recent years, it was seen less important issue than security of supply or technical quality by all the groups.

7.19 Although there is very strong consensus on the importance of the quality issues, the motivation behind the opinions may vary. It seems that companies see quality also as a balancing factor against the economic criteria while customers see it as a clear goal based on their needs.

7.20 The results suggest that additional services and products should not be included in the regulation system. However, in consequence of the non-discrimination rules in the Directive the monitoring of the unbundling and equal conditions is always of actuality.

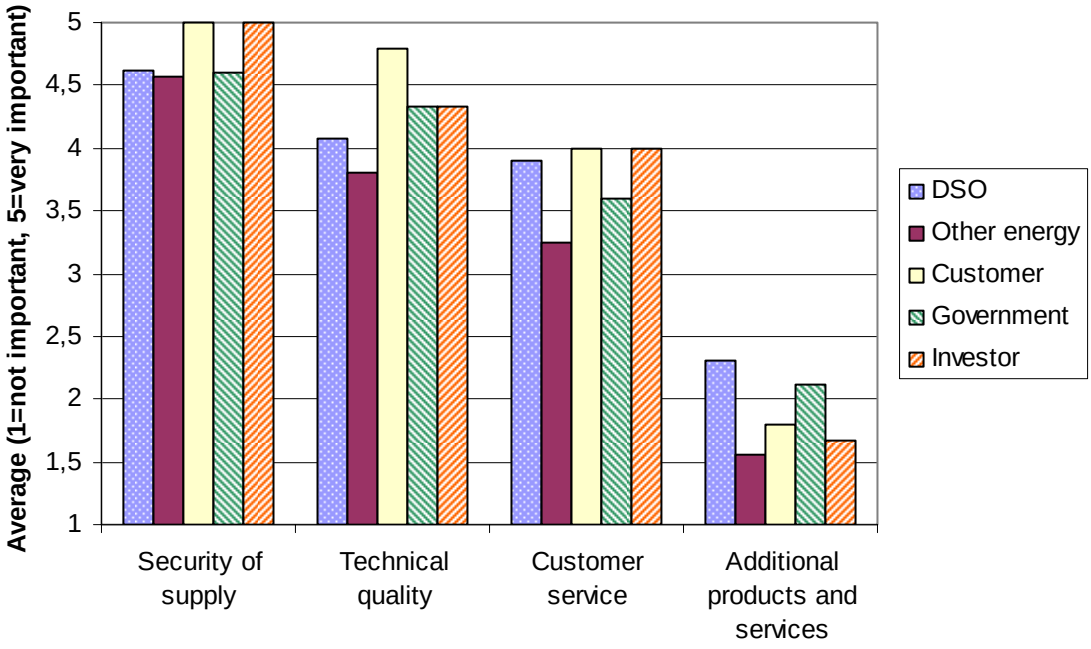

Figure 7-3 Relative importance of quality aspects in a well functionin regulation system

Equity, fairness and social and environmental issues

7.21 In equity and fairness aspects, access to networks and markets is acknowledged as the most important principle. Other aspects are also important characteristics of and basic principles behind a regulation system, not so much goals that the system should direct towards. Figure 7-4 presents the opinions on equity and fairness aspects.

7.22 There is general agreement that regulation should be fair, but there is potential conflict on what fairness means in practice. For example, is it fair that some company operates on a suboptimal scale, and maintains higher tariffs and at the same time tries to keep the local employment high? This is to a large extent a political question that deserves attention from relevant authorities.

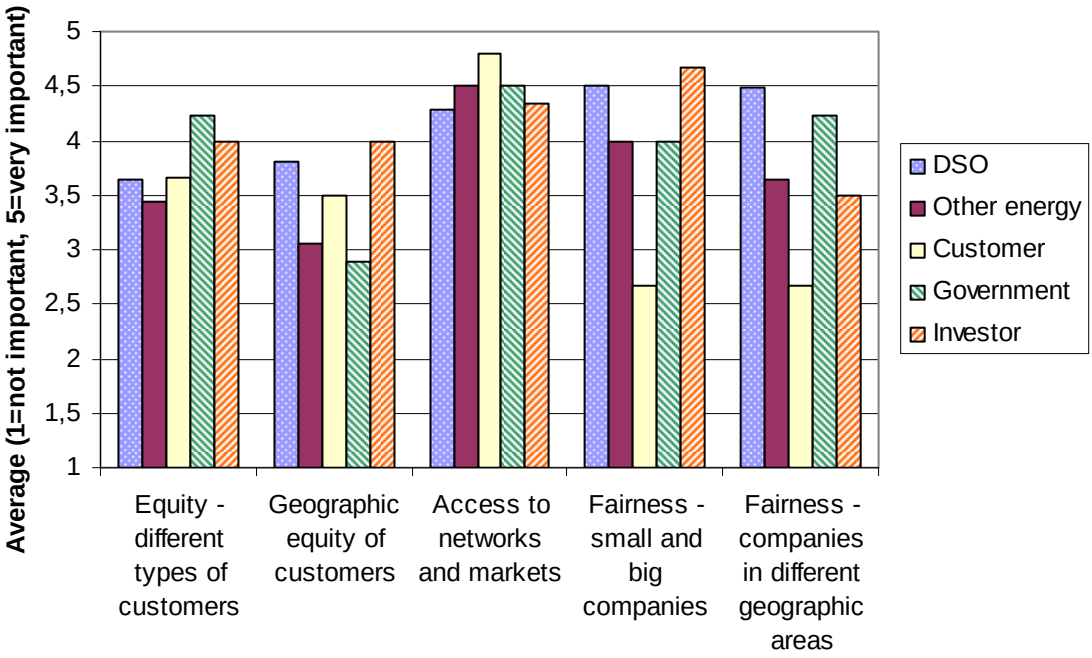

Figure 7-4 Relative importance of equity and fairness aspects in a well functionin regulation system

7.23 Furthermore, many of the social and environmental issues are indeed important – low environmental effects, compatibility with land-use planning, etc. This is illustrated on Figure 7-5. However, they are not necessarily limited to energy policy, but subject to separate rules and regulations. Out of these issues, safety is the most important aspect that potentially could be a part of the regulation system.

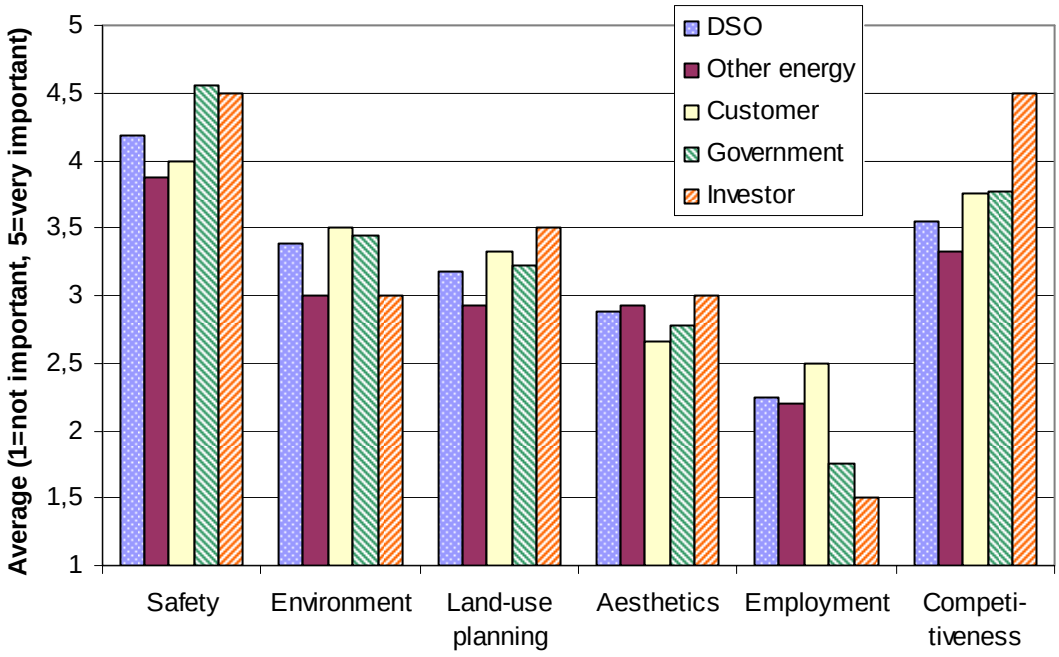

Figure 7-5 Relative importance of social and environmental aspects in a well functionin regulation system

Challenges related to system change

7.24 As there is practically unanimous consensus on the need for regulation, the key challenges are related to the implementation and change of implemented system(s). Practical concerns call for balancing between long and short term focus, economic and quality orientation, clarity and level of details, etc. The only clear message is that regulation should not direct the technical choices directly.

7.25 The country analysis show that the current regulation systems in the Nordic countries are well aligned towards common goals (creating markets in production and sales, creating efficiency and quality incentives in networks and guaranteeing reasonable tariffs), but they are philosophically and technically somewhat different. Furthermore, the countries are at different stages, but all have some sunk investments in the particular instruments used. Based on this observation, it is evident that political agenda needs to serve as a basis for changes. There is a need for finding a common commitment between the countries and this is an issue that cannot be solved at the regulators' level. Whatever solution chosen, it is primordial to create a win-win situation for the stakeholders in each country to forward the pan-Nordic idea.

Consequences for different stakeholder groups

7.26 This subsection analyses advantages and disadvantages of the suggested regulation model for different stakeholder groups. The analysis does not discuss the necessary transition period, but concentrates on the comparison of the current and the suggested mechanisms. Implementation issues are discussed in chapter 9.

7.27 The rest of the chapter is structured by stakeholder group. In addition to companies, regulators and customers, we have identified the following other stakeholder groups.

1) Owners (municipalities, institutional investors, households)
2) Personnel and unions
3) Other governmental organizations and authorities (ministries, municipalities, emergency supply agencies, competitions authorities, consumer authorities, etc.)
4) Electricity producers (as market players)
5) Electricity retailers
6) Transmission companies
7) NGOs (consumer organisations, environmental organisations)
8) Service and material suppliers of the distribution companies
9) Indirect competitors of electricity distribution

7.28 The text first discusses the customer perspective. This is followed by discussion on the regulators' and authorities perspective. Regulators are the most interesting stakeholder group as they need to balance between the partly conflicting goals of the stakeholder groups. The regulator perspective is also crucial for the potential implementation of the suggested model. The next subsection discusses the rest of the stakeholder groups to the extent that the suggested mechanism would lead to a significant change compared to the current situation. The analysis of the more detailed consequences in each country is presented in the last subsection. As the goals and objectives of the customers and regulators are to large extent overlapping, this part takes into account both perspectives simultaneously.

Customers

7.29 The survey and interview answers by customers and customer organizations show a clear focus on tariffs, both level and stability, quality aspects, especially security of supply and technical quality, and access to markets.

7.30 In the suggested mechanism, revenues (tariffs) and quality are addressed directly. The exact impact that the revenue yardstick model has on the tariffs depends on the parameters used, and hence it is somewhat unclear how strong incentives there are for tariff reductions. The pressure on tariff reductions is anyway twofold. Companies that are inefficient in the yardstick benchmarking have a very strong pressure to lower their tariffs. On the other hand companies that are efficient would have relatively weak incentives for further improvements. However, the model includes strong incentives for efficiency improvements and this will be reflected in the tariffs. Depending on the length of the regulation period the stability may or may not be affected. In the long run, once the companies have adjusted their behavior to the revenue yardstick model, the model should lead to stable tariffs and also stable revenues. The use of a yardstick model would not however increase the stability compared to ex ante revenue cap.

7.31 The separate quality incentive scheme clearly increases the focus on quality issues. The suggested model creates a clear incentive for improving the security of supply. The suggested quality model would not have a direct impact on technical quality, as this part of the regulation would not change.

7.32 As the suggested regulation model concentrates on the total revenue, there is no direct impact on equity aspects. It does not change the situation with respect to market entry barriers either.

7.33 The detailed analysis on a country level is presented below, after analyzing the general consequences from the regulators' and other stakeholders' point of view

Regulators

7.34 The regulators and other authorities have less clear focus areas than the customers. This reflects the fact that the regulators and other authorities need to balance between conflicting interests.

7.35 In economic aspects, the highest emphasis is put on high efficiency. Other important goals are low and stable tariffs, low costs and also stable long term profits and ROI.

7.36 The regulators and authorities give the highest importance of all aspects to the security of supply, and also technical quality is heavily emphasized. Access to markets is a very important fundamental goal, but the authorities also emphasize the equity of different types of customers, and the fairness of the model for companies in different geographic areas.

7.37 In total the authorities emphasize a wide variety of different aspects and these need to be balanced. In addition to the fundamental goals, the authorities are also interested in the implementation of the regulation model.

7.38 The suggested models gives clear cost cutting incentives and this is well in line with the objectives of the regulators. However the suggested model is philosophically very different from the current models, as operational and capital costs are not considered separately. This may lead to a situation where efficient firms make much higher profits than seen under the present schemes. However, there would be a very high pressure on the inefficient firms. As discussed above, the tariff incentives of the suggested model are dependent on the parameters. Anyhow, the impact on companies that are classified as efficient and those that are classified as inefficient is very different.

7.39 Separate quality model increases the importance quality issues. The primary focus is in the interruptions, and the impact on technical quality would be indirect.

7.40 Concerning the implementation issues the suggested model would lead to a situation where the regulators would avoid the problematic definitions of asset base and rate of return. There would not be a need for defining an efficient operative cost level either. However, there would still be the problem of defining operational environment for the companies. In this respect the situation would not change. Compare to the current situation in all the countries the suggested model requires less data.

Other stakeholders

7.41 The impact on the other stakeholders is significantly more difficult to analyze, as this is often dependent on the whole regulatory approach, not just the

mechanism. And furthermore the issues that are dependent on the mechanism are often linked to the detailed way of implementing the regulation mechanism. When we analyze the situation on the level of detail that is possible in this report, we see that the direct impacts on the other stakeholders are rather limited.

7.42 Personnel would most probably face the increased tariff and cost reduction pressure created by the suggested model. As staff is one of the key elements in the cost structure, it is very difficult to avoid this situation. However, also here the differences between the companies are significant, and the positive side of the model is that there is no absolute productivity goal and hence the position of the employees would pretty much resemble the situation in companies that operate in normal competitive markets. The same applies to service and material suppliers. These may however benefit from the potentially increasing outsourcing caused by the increased pressure on efficiency.

7.43 As the regulation mechanism has no direct impact on the responsibilities of the DSOs, the impact on the safety issues, energy market players, transmission level etc. is very limited.

Country level impacts

7.44 This subsection presents a summary of the expected implications that the suggested mechanism would have compared to the current situation in each country.

7.45 Compared to the current Danish situation the conclusions from the regulators point of view are mostly equal to the conclusions from customer point of view. The first three points present the conclusions linked to these shared objectives. The additional aspects related to profit level and equity and fairness can be summarized in the last three points:

1) The direct impact on the tariffs would probably be fairly limited as the DSOs are to a large extent owned by municipalities and by cooperatives. Hereby the final consumers' interests in low tariffs have a quite direct and in some cases apparently strong influence on the behavior of their DSO. The suggested model would not directly change this situation.
2) There would be more incentives for efficiency improvements. However the cost cut incentive for non-profit companies would be smaller than for for-profit companies.
3) More focus on quality through a more transparent system. However, this far there has been maybe more favorable rules for investments.
4) Most probably a fairly limited effect on the profit level of the companies, as many companies did not collect maximum revenue during the price cap system.
5) No direct impact on equity of the customers, but the suggested mechanism would create a pressure to get rid of the significant cost differences between the DSOs.
6) Fairness of the models for the DSOs operating in different environments depends on the implementation of the model.

7.46 In Finland the suggested model would lead to the following implications. Many of the aspect are again shared by customers and regulators. The first four points are most relevant for the customers.

1) Stronger incentives for efficiency improvements, especially for the inefficient companies, as the current cost cap model includes the same X-factor for all the companies.
2) Direct impact on tariffs would strongly vary between the companies, and there would be strong pressure on the companies that are classified as inefficient. The stability might be lowered, especially during the transition period and if the regulation period is shorter than currently.
3) The incentives for quality, especially security of supply, would be strongly increased as in the current regulatory model there is only rather moderate standard compensation for customers for longer interruptions. As there would no longer be separate treatment of costs and investments, the incentives for maintaining and developing the network would be enhanced.
4) The suggested model does not bring any specific incentives for investments. However it will be easier to assess the return on investments, the regulator will be more committed in a pan-Nordic set-up, and it makes it the responsibility of the firm to level out investment cycles.
5) Most probably a fairly limited effect on the average profit level of the companies, but the connection between efficient operation and profit would be much stronger that before. Hence the model may lead less stable profit levels and higher variation in profit between the companies.
6) No direct impact on equity of the customers, but stronger pressure on efficiency should have an impact on the tariff differences between the DSOs.
7) Fairness of the models for the DSOs operating in different environments depends on the implementation of the model.

7.47 Compared to the current Norwegian situation, the suggested model would lead to the following changes. The first points are again the ones with most relevance for customers.

1) The suggested mechanism would provide much stronger incentives for efficiency improvements, as the slow catch up in the x-factor would be replaced by revenue yardstick. Also the tariff level of the companies that are classified as inefficient would need to be lowered.
2) Depending on the specifications of the mechanism, the suggested system might add pressure for the smallest companies. This might lead to structural changes, e.g. mergers. In general the pressure for lowering the tariff would vary from company to company depending on the efficiency score.
3) Changes in the length of the regulation period would probably decrease the stability of the tariffs especially in the beginning.
4) There would be no changes in quality issues, as the suggested model would have a lot of similarities with the current CENS model.
5) The mechanism would most probably have a fairly limited effect on the average profit level of the companies, but the connection between efficient operation and profit would be much stronger that before. Hence the model may lead less stable profit levels and higher variation in profit between the companies. Depending on the specifications of the model, the impact would probably be highest on the small companies.
6) The mechanism would have no direct impact on equity of the customers, but stronger pressure on efficiency should have an impact on the tariff differences between the DSOs. This might not be seen as politically desirable as it might lead to mergers of the smaller companies.

7) Fairness of the models for the DSOs operating in different environments depends on the implementation of the model.

7.48 Compared to the current situation in Sweden the expected impact of the suggested model includes the following aspects. However, there is limited experience of the current Swedish model and the incentives it provides, and this makes it difficult to draw clear conclusions.

1) The suggested mechanism would possibly give a slightly more moderate pressure on the tariffs than the current technical norm model. However the impact depends in the way the technical norm model is eventually applied. The pressure on tariffs would anyway be higher that in the light handed regime and it would be concentrated on those companies that are classified as inefficient.
2) The quality incentive scheme would give more incentives for quality improvements if the quality model has a large enough range of application.
3) The mechanism would most probably have a fairly limited effect on the average profit level of the companies, but the connection between efficient operation and profit would be much stronger that before. Hence the model may lead less stable profit levels and higher variation in profit between the companies especially in the beginning.
4) The mechanism would have no direct impact on equity of the customers
5) Fairness of the models for the DSOs operating in different environments depends on the implementation of the model.

7.49 Table 7-1 summarizes the potential advantages and disadvantages of the model based on the most important goals and objectives of the customers. For each country the comparison is done relative to the current model.

Table 7-1 Potential advantages and disadvantages of the suggested regulation model compared to the current model

	Denmark	Finland	Norway	Sweden
High eff. and low costs	+	+	+	+
Low tariffs	+/–	+	+	+
Stable tariffs	+/–	+/–	+/–	+/–
Stable profit and ROI	–	–	–	–
Security of supply	+	+	+/–	+
Technical quality	+/–	+/–	+/–	+/–
Access to networks and markets	+/–	+/–	+/–	+/–
Equity and fairness	+/–	+/–	+/–	+/–
Implementation	+	+	+	+

Feasibility at the European level

7.50 Below we briefly review the current IEM directive with respect to distribution system regulation before discussing the regulatory compatibility of the proposal with respect to the European regulatory framework.

Key legislation

7.51 Revamped directive (2003/54/EC) entered into force 1. January 2004 in most countries, with a final deadline 1. July 2007 for countries that have not yet unbundled retail and distribution (read: France and Germany).

The Role of the DSO

7.52 Chapter V of the Directive is devoted to DSOs. It specifies that tariffs should be non-discriminatory and cost-reflective and should take into account the marginal avoided network cost from distributed generation and demand-side management. A regulator may choose not to impose unbundling on DSO with less than 100,000 customers. The more detailed interpretations are provided in the EC (2004b), which is primarily devoted to the residual retail tasks of the DSO (information, supplier switching, metering, and supplier of last resort). The universal service obligation is emphasized. The EC notes the necessity to impose quality regulation through incentives and penalties for DSOs. However, the specific regulations pertaining to DSO all concern the non-discrimination of customers through tariff structure, information disclosure, meter changes, fees or delays, service conditions and payment terms. A new obligation (V, art 15 § 2d) for the DSO concerns the *compliance officer* responsible for the submission of a public report to the national regulator on the measures taken to guarantee non-discriminatory conduct. Interestingly, the directive specifies the tariffs and terms for balancing services operated by DSOs (V, art 14 § 6), whereas the TPA tariffs are the competencies of the member state (VII, art 20 § 1).

The Role of the National Regulator

7.53 Concerning the national regulator, the Directive requires its existence and some minimum competence, including ex ante tariff approval, conflict resolution and monitoring or contractual terms for TPA. Preambles (EC, 2004a) to the directive outline the tasks and competences of the regulator. Regulators do not need to be unique within or for a given country, i.e., member states may delegate regulation to inter-regional regulators. An effective national regulation should be enforced with clear sanctions for lack of compliance, e.g. in unbundling and transparency. The EC notes that suspension of concession or license to operate is conceivable in extreme cases, but warns for the unnecessary regulatory risk that might result from unconstrained discretion.

7.54 The crucial passage on regulation system design merely states a limit for the discretion, based on ex ante decision that may be appealed.

> *"The regulatory authorities shall be responsible for fixing or approving, prior to their entry into force, at least the methodologies used to calculate or establish the terms and conditions for: (a) connection and access to national networks, including transmission and distribution tariffs. These tariffs, or methodologies, shall allow the necessary investments in the networks to be carried out in a manner allowing these investments to ensure the viability of the networks..."*
> (Directive 2003/54/EC, 23 § 2a)

7.55 EC (2004a) defines the ex ante provision to extend to (i) the regulatory asset base (RAB) and any investments during the period, (ii) the allowable rate of return on the RAB, (iii) allowable depreciation rates on RAB, and (iv) operating costs (sic!). The methodology for the ex ante evaluation should be based on a "*comprehensive understanding of the cost drivers of the regulated businesses*".

7.56 Three methodologies are mentioned in EC (2004a), without any claim for exhaustiveness:

1) Ideal network models
2) National yardstick regimes
3) International benchmarking (yardstick) regimes

7.57 The role for *ex post* regulation is delimited to dispute settlement, monitoring of actual revenues and technical regulation of network access and installations.

Analysis

7.58 To a large extent, the previsions in the directive with respect to the delegation of rights and tasks to regulators and DSO are respected in both the current and the proposed approach. This concerns in particular all dispositions related to unbundling, customer protection, universal service obligations and appeal procedure. The quality regulation proposed also complies fully both with the intention of the preambles and the dispositions of the directive as being a forward-looking, credible and quality provision incentive regulation based on technical and economic grounds.

7.59 The crucial difference lies in the revenue yardstick mechanism, where two elements must be discussed: (i) the timing of decision and (ii) the basis of the methodology.

7.60 The revenue yardstick model can be interpreted as a "methodology used to calculate or establish [tariffs]" known prior to a regulatory period. The details of the methodology, the type, date or scope of its information, are here inessential and subject to the competencies of the national regulator. However, the directive (Directive 2003/54/EC, 23 § 4) does not allow the regulatory authority to waive their right to review terms and conditions during a regulatory period, which limits the regulatory commitment. Further, the terms and conditions are required to be approved prior to their being put in force, which calls for an ex ante logic[1]. Hence the provision in the proposed regulatory approach for the regulator to intervene in the tariff setting if the decision does not correspond to the carry-forward of the yardstick and/or a projected debt for the regulatory account.

7.61 The Directive and its preambles are inherently input-oriented, in contrast with this report that adopts an output-oriented approach. A potential problem might arise if a connected client would appeal a tariff (VII, art 23 § 5) evoking specifically the

[1] Note that the compatibility of the Swedish and Finnish tariff delegation regulation with this provision is controversial, but beyond the scope of this report.

provision that distribution tariffs should be cost-reflective. Since the proposed methodology does not permit the regulator to directly assess the cost of the service, other provisions must be taken to ensure the monitoring in this sense. We leave the in-depth analysis of this point for further work, while noting that a pragmatic solution could be to adopt an cost-efficiency norm using the same model as in the revenue yardstick model as a mean to establish a monitoring instrument for compliance with the directive. However, the exact dispositions for the application of such ceiling remains to be determined, if at all necessary.

Summary

7.62 Clearly, harmonization of regulation, standards, operating conditions and business practices is not only in line with the EC policy, but actively promoted. Although DSO regulation as such may be a fairly uncontroversial national competence, the pressure is clearly mounting against the regulators to demonstrate their effectiveness. The new provisions in the directive already push in the direction of harmonization by resolving some methodological issues (ex ante/ex post) and by opening for the recognition of regional regulators. As the Nordic countries already stand out among the landmarks in deregulation, a closer collaboration between e.g. the Nordic Council, Forum of Nordic Energy Regulators (FNER) and Nordenergi on the promotion of a common regulatory model would surely be more than welcome in Brussels.

Conclusion

7.63 The survey and interview material show that different stakeholder groups are to large extent very unanimous about the goals and objectives related to electricity distribution. Most important economic aspects are stable tariffs and return on investment, and high efficiency. Natural conflicts are related to the level of tariffs and profits. Quality aspects are as important as the economic aspects and security of supply is the most important single goal. Also high technical quality is seen as very important goal. Equity and fairness issues are mostly seen as underlying principles, not primary goals. Out of these aspects, access to networks and markets is the most important one. Depending on the stakeholder groups, equity of customers and fairness for different types of companies are also seen important. Social and environmental aspect is clearly the least important group of aspect in a well functioning regulation. These important aspect need to be guaranteed in some other way.

7.64 Most important stakeholder groups discussed here were customers and regulators. Impact on other stakeholder groups would be fairly limited, as the analysis concentrates on the changes in the regulation mechanisms, and most of the regulatory approach would be unchanged.

7.65 Most important changes would be related to the incentives for lowering tariffs and improving cost efficiency. The suggested mechanism would set a very high cost reduction and tariff cut pressure on those companies that are classified as inefficient. This would have a very significant local effect, and it would probably lead to structural changes in the industry. On the other hand some efficient companies would probably make more profit than under the current regimes. Hence the suggested approach would give much stronger incentives for improving efficiency. In the short run the suggested mechanism would decrease the stability of tariffs and profits, but in the long run it should lead to a stable situation.

7.66 The suggested mechanism would increase the importance of quality in Denmark, Finland and Sweden. The suggested quality incentive scheme would give incentives for improving the security of supply. Other quality dimensions would still need to be covered with separate rules and norms as in the current regimes.

7.67 The impact on equity and fairness issues would most likely be fairly limited, but this is very much dependent in the choices made in the implementation of the mechanism. For example differences in the operational environment need to be taken into account to guarantee fair regulation. The suggested mechanism would not have any direct impacts on the social and environmental goals.

7.68 The suggested model is judged to be compatible with the EC directives, in particular the ex ante requirement. The remaining uncertainty is related to the procedural delegation of in-period tariff setting to the DSOs. Further interaction and work on this issue are necessary to determine the exact consequences of the directive with respect to the tariff approval competency.

8. Market and Owner Analysis[2]

Outline

8.01 This chapter provides market and owner-analysis of the overall proposal, excluding downstream clients but including both supply markets (services, energy) and the financial markets. The study closely relates to the key success factors formulated in NEMESYS (2005a) and addressed in NEMESYS (2005b) for the stakeholders.

Capital markets

8.02 In a long term perspective, capital is a scarce resource for the DSOs – precisely as it is for all other economic activities, and irrespective of organizational and legal form of the DSOs. Aging infrastructure currently calls for substantial investments in this sector in the years to come. A long term challenge for the sector is therefore to remain competitive in the capital markets for debt and equity.

8.03 The critical question for any regulation scheme is thus which impact the scheme has on the companies' ability to attract equity and arrange for funding in debt markets. The proposed model has two important features with respect to the financial markets.

1) There are strong incentives, also long term, to improve efficiency, as cost reductions can be kept with the companies as increased profit.
2) Price competition is encouraged, as tariff reductions can help a DSO improve its efficiency score.

8.04 Several conclusions can be drawn from this. Firstly, to the extent the regulatory mechanisms stimulate efficiency improvements; the DSOs will in general improve their ability to attract both debt and equity. Efficient firms are more attractive than inefficient firms for both lenders and owners, as firms in an efficient sector simply have better long term prospects than inefficient sectors.

8.05 Secondly, DSOs failing to reduce inefficiencies might face particular challenges in the equity markets, as inefficient firms will not be able to reap as high profits as the efficient companies. But consequently, it is questionable whether inefficient firms will remain inefficient, or if they will rather improve their efficiency score. The competitive pressure created by the yardstick regulation will contribute to a positive development also for inefficient firms. One example of this is innovations

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[2] It is not a precise science to distinguish what is the impact from the actual design of the proposed regulation model, and what is the impact from the fact that the Nordic countries eventually employ a harmonized scheme in all countries. As the markets for inputs to DSOs are multinational, the harmonization itself is essential for reaching the desired impact on the relevant markets.

made by efficient firms, due to the competition. Sooner or later, such innovations will be adopted also by inefficient firms – as a result of the competitive pressure.

8.06 Thirdly, to the extent price competition will arise, this is likely to stabilize prices (tariffs) both geographically and over time. As costs are not expected to be equally stable, this implies unstable profits, which might suggest a disadvantage or risk premium in the financial markets. But it is not clear that the financial markets will emphasize unstable profits as much as the markets will appreciate a regulatory scheme that leaves the DSOs with sufficient discretionary power to do their own long term planning - without being forced into uncertain negotiating processes with the regulator before long term investments can be made.

8.07 Fierce price competition is also likely to put a downward pressure on profits in the short term, but in the long term, profits are more likely to stabilize on a level sufficiently high to attract appropriate financing. This follows directly from theory of long term equilibrium.

8.08 The fact that the model implies a harmonized regulatory scheme in the four Nordic countries also eases financing, as both lenders and equity owners can easily reduce country specific risks by diversifying their investments across the region.

Supply markets

8.09 Supply markets include the electricity market and the various services DSOs are buying externally.

8.10 The role of DSOs in the electricity market is minor. As such, a DSO is neither a generator nor an end user or an agent buying in the electricity market on behalf of one or more end users. But still, the DSOs have an important role to play regarding facilitating the electricity market, e.g. ensuring access to the market on fair conditions. However, to the extent this role is regulated, it is regulated directly and will hardly be included within the yardstick model proposed here.

8.11 When DSOs are buying energy to cover for grid losses, they also have a quite passive role in the electricity market. First, it is relatively small volumes. But equally important, this demand is naturally associated with a price elasticity of zero. The quantity demanded to cover for network losses is easily predicted, and does not play an active role in the price formation in the electricity market.

8.12 The design of the regulation model will thus hardly have any impact on the electricity market as such.

8.13 Some of the services and the equipment marketed towards DSOs are, however, quite dedicated to this sector. The purchasing behavior of the DSOs might have a substantial impact on this sector as well. The question is then to which extent a yardstick regulation will change the behavior of DSOs in these markets, and how this change eventually can impact the relevant markets.

8.14 The keywords are once again competition and increased efficiency. To the extent the DSOs will face increased competition, this will inevitably lead to increased pressure on prices in markets, in which the DSOs enjoy a large market share on

the demand side. Transformers might serve as an example of a market, in which the DSOs are not the sole category of buyers, but rather the most important in terms of market share (on the demand side).

8.15 Yardstick regulation seems to have one important impact on the services market: Increased competition between DSOs will put a similar pressure on their suppliers, in particular those who receive most of their revenues from DSOs.

8.16 We can refer to the destiny of manufacturers of electricity generation equipment, such as turbines and generators, for a similar experience: As competition was introduced in the electricity markets 10 – 20 years ago, the producers' demand for new power stations, and consequently for their components, declined sharply. As a response, the supply sector reduced their own costs significantly, and thereby improved the competitiveness of their customers.

8.17 Similarly, it is reasonable to expect a similar effect in the supply markets, in particular in the most specialized markets: The increased competitive pressure between the DSOs will be reinforced by reduced costs and/or improved quality in the supply markets. Competition stimulates innovation, not only with the DSOs, but of course also among their suppliers.

Ownership

8.18 Quite few of the current owners in the DSO sector have actively chosen the role as owner in the local DSO – it is a role inherited from the era before deregulation of the electricity markets, identification of and incentive-based regulation of natural monopolies. Initially, it was hardly questioned whether the municipalities should participate in the electricification process that took place 100 years ago. Private ownership was normally chosen only if the local municipalities had too weak finances to participate.

8.19 A key question is thus which impact the yardstick regulation will have on the ownership structure.

8.20 The yardstick regulation proposed here will create the basis for a pan-Nordic equity market in the DSO-sector. This equity market will to a larger extent than currently be based on normal equity market logics, as the regulation scheme will recognize company profits as a normal and expected outcome of the regulation. And as the regulation is based on revenues rather than costs, it will be easier for players in this equity market to make valuations of equity in different companies, as book values and market values of underlying assets will be less important in the valuation process. This leads to more liquidity in the DSO equity market, and improved options for current owners to change their exposure in the sector according to their current preferences.

8.21 Obviously, if current owners easily could chose whether to continue as an owner or leave the sector, some would definitely sell off their assets, whereas others would continue or even increase their exposure in the sector. This leads to a two-fold conclusion regarding equity:

1) The regulation will kick-off some structural changes in the industry that have not been carried through yet.

2) The future owners will be more dedicated and concerned than some of the current owners.

Securing future investments

8.22 A subchapter addresses the investment provision problem from a high-level viewpoint, addressing the concerns by industry of capital provision for reinvestments, upgrading and new investments under the new regime. Analogies can be made from generation or other regulated infrastructure industries.

8.23 A frequent concern among industry leaders is to which extent the DSO sector will be able to raise sufficient capital for reinvestments, upgrading and new investments necessary to fulfill the tasks of the DSOs. A lot of owners have taken every opportunity to take any profit out of the companies and spend the money in other areas and sectors. The level of investments has been fairly low during the last 10-15 years, as compared to the preceding 15 years. Quick calculations suggest a time horizon of up to 100 years to replace all current installations, if the current investment frequency will continue.

8.24 It is important to keep in mind that generally, for the whole electricity sector, the very high level of investments in the 60-ies, 70-ies and 80-ies is the main motivation for the deregulation process. This is particularly true for electricity generation, but is to some extent also valid for the DSOs and TSOs. A reduced investment speed during the 90-ies is consequently a sign that the new electricity policy has had the desired consequences. Consequently, the low level of investments is generally not a sign that "something is fatally wrong with the regulation of the sector".

8.25 However, ever since the deregulation started 15 years ago, huge investments have been made in the electricity sector. But most investors have focused on existing power plants (generation companies) and existing grids (DSOs) rather than new plants and networks. If "second hand" items are far cheaper than new build, it is quite logic that investors have focused on existing assets.

8.26 For generation, there are very clear signs that investments in new capacity are now being considered seriously in multiple companies. Some larger projects have already passed decisions and are being implemented. The readers will also know that a number of smaller projects have been developed during the past 10 years.

8.27 Hence, it is far from obvious there really exists a general, underlying financing problem in the sector. On the contrary, it seems as if the generating sector is about to prove the opposite: That electricity generation is attractive investments for the time being.

8.28 But to the extent this is a real problem for the DSO sector, the proposed regulation scheme will work to mitigate the situation. As pointed out above, the yardstick regulation of revenues will allow DSOs to pay back the investors what they demand. Hence, the regulation will ensure the attractiveness of the sector in the capital markets – in a more efficient way than the current regulation schemes does.

8.29 As the regulation provides strong incentives to efficiency improvements, it is fair to assume the most efficient companies will attract capital easier than less efficient companies. Assuming some inefficient companies experience problems of financing necessary investments, this will provide opportunities for the efficient companies to take the lead in structural changes, buying the less efficient companies. In this way, both the potential financing problem will be solved and the efficiency will improve in the previous inefficient companies.

Conclusions

8.30 The yardstick regulation will improve the sectors ability to attract sufficient funding for future investments. Three keywords are central: efficiency improvements, competition and discretionary power.

8.31 The yardstick regulation will most likely also impact the competitiveness of the specialized supply services via the increased price competition in the DSO sector.

8.32 The yardstick regulation will improve liquidity of equity and provide for more focused, active and concerned owners.

8.33 To the extent there really exists a general financing problem for the electricity sector, the yardstick regulation will mitigate or reduce the problem significantly.

9. Towards an implementation

Introduction

9.01 This chapter sketches some paths for implementation of the approach, drawing on the similarities and analogies with existing regimes from A and the Dynamic Regulation approach. It also addresses the limited catch-up problem.

9.02 Regulatory policies always change under pressure from different stakeholders debating, challenging and contributing the current approaches. Thus, the implementation problem should not be seen in isolation, as this very report in itself is likely to form part of such debate rather than providing a detailed roadmap to its completion. Nevertheless, one may differentiate four important phases in the implementation.

Anchoring phase

9.03 The proposal may be perceived as radical by both firms and regulators in that it changes the mode of competition in the sector. Previously, firms were interacting with the regulator as with a mighty client, in the proposal they would be both more free, yet subject to more competition. This change is not trivial and should be both well explored (cf. further studies in Chapter 10) and understood by all parties. In this context, it is imperative that the proposal is widely disseminated, discussed and improved by the Nordenergi member organizations. The historic and unique initiative to jointly propose a new regulatory approach from the industry side is an enormous strength for the implementation phase. However, to achieve full support, it is important that the proposal and some limits for its development are anchored among firms as well as industry associations.

Development phase

9.04 Provided the policy makers (Nordic regulators, governments and EC directorates) adopt and retain the essentials of the proposal, the next step would inevitably be the development of the key elements in the regime; the DSO Task, the frontier model and the quality incentive parameters. This phase is defined and conducted by the regulators, preferably after establishing the regulatory framework agreement that was discussed in Chapter 5 as a common vision statement for the entire project.

9.05 Although the approach is new, one should not overestimate the need for development in this phase. The proposal is well aligned with the principles for all four regulators and two (Denmark and Finland) are actually overhauling their regimes along the lines of this study. Both the frontier yardstick principle and the quality incentive mechanism are also close to the new Norwegian regulation, opens for a feasible adaptation. The Swedish regulation is very close in terms of stated paradigm, the yardstick principle and the quality reimbursement mechanism are anchored, yet the underlying mechanism is substantially different.

Sequential launch phase

9.06 In the event of an adoption of the proposal, the approach can be flexible in its implementation in both time and components. Given that the regulators to uphold credibility in any changes would need to assure current regimes for at least one regulatory period, a possible scenario would be to prolong the interim regulation for these countries and to launch the development by a joint effort for e.g. Denmark and Finland. The regulators in Norway and Sweden can then pursue separate alignment projects in parallel with the common specification that is first to be implemented in Denmark and Finland. The first candidate for the harmonization is likely the quality incentive scheme that should face little or no opposition in any of the countries. The yardstick model may be introduced gradually during this overlapping period, potentially by offering a choice to change or remain on the national regulation until the end of the ongoing period.

Transition phase

9.07 Once the Nordic regulation has been uniformly adopted as in the proposal, specific transition regimes should be made to address the limited catch-up problem in changing mode of competition. The model is particularly well adapted to perform this in a transparent manner through the parameters α and β (incentive powers) that should be gradually increased from a lower level, say 0.5, to the optimal level during a period that depends on the initial difference in tariff level and efficiency. As long as the timeline for the tune-up of the incentive power of the yardstick is credibly established, this transition phase would entail no losses of social welfare in the long run.

10. Summary

Lessons from the Theory

10.01 Dynamic yardstick regimes stand out as superior alternatives to other regimes such as cost-recovery plans, CPI-X revenue caps, franchise auctions and technical norm models. On the one hand, they bridge the information gap between the regulator and the firm, in that they form a 'pseudo'-market for the firms. This allows the regulator to concentrate its efforts to areas where it is necessary and relevant, such as monitoring of terms, industry structure and quality development. On the other hand, they offer a credible alternative in that they minimize the risks for in-period opportunism by the regulators and the firms.

10.02 Dynamic yardstick schemes based on Data Envelopment Analysis (DEA) solve many of the usual CPI-X problems, including risk of bankruptcy with too high X, risk of excessive rents with to low X, ratchet effect when updating X, arbitrariness of the CPI measure, arbitrariness of the X parameter, and inability to include changing output profiles. The most important difference between a yardstick schemes and a more traditional CPI-X regime is that the firms are compared to actual cost frontiers rather than projected cost frontiers. This reduces the informational and analytical requirement put on the regulator and allows for a more precise inference of actual performance. It hereby also allows for better incentives.

10.03 While some may intuitively see the lack a priori knowledge about allowed costs as an increased business risks, the risk is actually reduced. It is more risky to work with a fixed income and changing costs than to work with an income that more closely tracks the cost development.

10.04 However, two issues emerge from the theoretical analysis: (i) quality regulation must be handled in a robust and transparent way to promote investments. (ii) the basis of comparison for the yardstick model must be well selected as to avoid problems related to asset age, investment cycle, ownership and demand structure.

NEMESYS proposal

Quality incentive scheme

10.05 Quality regulation and in particular the provision of incentives to make appropriate quality adjustments is important in regulation – and in particular in a regulatory context where the incentives to reduce costs are subject to quite high powered schemes. Based on the asymmetry of information about costs and benefits, we have identified a simple but nevertheless potentially very useful approach to the regulation of DSO quality, namely the marginal cost approach. The quality incentive scheme proposed is based on reliability measures, energy not supplied and interruption frequency, supplemented with restrictions for secondary or correlated attributes, such as voltage and commercial quality.

Revenue yardstick model

10.06 To solve the investment provision problem, the capital valuation problem, the problem of intra-Nordic regulatory competition and to create robust regulation for any technical developments, we propose a competitive, modern and fully output-based yardstick model based on revenues for a standardized DSO task description.

10.07 The revenue yardstick model is simple to defend and visualize to other stakeholders. Its focus is on value for money, tariff payments in relation to the complexity of the task and comparable offers, and mimics closely the logic of a competitive market.

10.08 The revenue yardstick model leverages the firm's need for financial stability (ex ante tariff delegation) with the regulator's mission to ensure efficiency (ex post yardstick correction). The incentive power can be set to "tune" the regime to different capital risks. The revenue yardstick model gives potentially high incentives for restructuring, likely to be capped in a transient situation.

10.09 Some institutional and information changes are proposed to facilitate the common regulation, to improve transparency and competition and to diminish the regulatory costs, such as common task descriptions, direct quality compensation payments for larger disturbances, coordinated metering and information exchange standards, as well as a common regulatory mission statement.

Firm-level feasibility

10.10 Table 6-5 below sums up the above analysis through a list of advantages and disadvantages from the firm's perspective. The dimensions firm size, nationality and ownership have also been discussed.

Table 10-1. Advantages and disadvantages from the firm perspective

	Firm perspective		Different consequences dependent on		
	Advantages	**Disadvantages**	**Size**	**Nationality**	**Ownership**
Optimal allocation of decisions and information	No micro management by the regulator		Should not be the case	Dependent on other regulations	Should not be the case
Incentives for sound industry structural changes	Strong incentives for increased profits through structural changes	Inefficient companies might be "forced" to mergers and aquisitions	Smaller companies might be more exposed to structural changes	Different national rules for national and Pan-Nordic mergers and aquisitions?	Local public owners might be hesitant to structural changes
Incentives for efficiency improvements	Efficient companies and efficiency improvements are rewarded	Inefficient companies might earn very low profits	Should not be the case with a fair efficiency model	Harmonization of data is required	Public owners with conflicting goals might not pursue efficiency improvements - lower profits
Incentives for tariff reductions	Tariff revenues as input - more stable tariffs?	Fierce price competition might reduce profits	Should not be the case	Should not be the case	Public owners - already lower tariffs through politically determined tariffs?
Incentives for customer oriented quality implications	Quality improvements increase profits	Might be hard to get the status quo level and the quality costs right	Should not be the case	Should not be the case with "correct" quality costs and status quo levels	Should not be the case
Unbiased firm-level performance assessment	Unified and well defined criterias	The design of the efficiency model is essential with regards to fairness	The efficiency model should not discriminate with regards to size	The efficiency model should not discriminate with regards to nationality	The efficiency model should not discriminate with regards to ownership
Low administrative costs of regulation	Generally low probability for higher adm costs than today		Smaller companies might get increased adm costs due to the regulatory frequency	Only for a transitional phase	Should not be the case

10.11 The revenue yardstick model will be advantageous for efficient companies, but will lead to low allowed profits for inefficient firms. In other words, efficient companies are awarded and efficiency improvements should pay off. Ownership and size might influence on whether or not the firm responds to the incentives given by the revenue yardstick and quality incentive models. Some small firms with local public owners might pursue other goals than profit maximizing. These companies will be given low profit by the revenue yardstick model.

10.12 Based on the analysis of different profit strategies, we can see that the suggested mechanism affects these in slightly different ways and the different strategies have different implications on the consequences of the mechanism. Companies with cost minimizing non-profit strategies play a key role here.

10.13 Yardstick competition between profit maximizing companies will in the short run lead to decreased profits, as inefficient companies would not be able to make profit. The differences would even out when the companies have adjusted their operations to the new situation. However the pressure on efficient units would be moderate. Non-profit cost minimizing companies would add a clear pressure by pushing the yardstick frontier towards zero profit level. However, by excluding non-profitable firms from the reference set, the yardstick model guards from "dumping" strategies. The non-profit companies with operational slack would not have an impact on the frontier, but they would be forced to limit the slack to the level of the profit of the efficient companies.

10.14 Empirical data from Finland and Sweden provide mixed evidence on the actual existence of non-profit cost minimizing companies and their efficiency. Anyhow, the number of these companies seems to be very limited, and excluding companies that make loss from the yard stick reference set would further decrease the impact. However the true effect of the different profit strategies is dependent on the parameters of the model and further analysis would be needed for drawing the final conclusions.

Policy-level feasibility

10.15 The survey and interview material show that different stakeholder groups are to large extent very unanimous about the goals and objectives related to electricity distribution. Most important economic aspects are stable tariffs and return on investment, and high efficiency. Natural conflicts are related to the level of tariffs and profits. Quality aspects are as important as the economic aspects and security of supply is the most important single goal. Also high technical quality is seen as very important goal. Equity and fairness issues are mostly seen as underlying principles, not primary goals. Out of these aspects, access to networks and markets is the most important one. Depending on the stakeholder groups, equity of customers and fairness for different types of companies are also seen important. Social and environmental aspect is clearly the least important group of aspect in a well functioning regulation. These important aspect need to be guaranteed in some other way.

10.16 Most important stakeholder groups discussed here were customers and regulators. Impact on other stakeholder groups would be fairly limited, as the analysis concentrates on the changes in the regulation mechanisms, and most of the regulatory approach would be unchanged.

10.17 Most important changes would be related to the incentives for lowering tariffs and improving cost efficiency. The suggested mechanism would set a very high cost reduction and tariff cut pressure on those companies that are classified as inefficient. This would have a very significant local effect, and it would probably lead to structural changes in the industry. On the other hand some efficient companies would probably make more profit than under the current regimes. Hence the suggested approach would give much stronger incentives for improving

efficiency. In the short run the suggested mechanism would decrease the stability of tariffs and profits, but in the long run it should lead to a stable situation.

10.18 The suggested mechanism would increase the importance of quality in Denmark, Finland and Sweden. The suggested quality incentive scheme would give incentives for improving the security of supply. Other quality dimensions would still need to be covered with separate rules and norms as in the current regimes.

10.19 The impact on equity and fairness issues would most likely be fairly limited, but this is very much dependent in the choices made in the implementation of the mechanism. For example differences in the operational environment need to be taken into account to guarantee fair regulation. The suggested mechanism would not have any direct impacts on the social and environmental goals.

10.20 The suggested model is judged to be compatible with the EC directives, in particular the ex ante requirement. The remaining uncertainty is related to the procedural delegation of in-period tariff setting to the DSOs. Further interaction and work on this issue are necessary to determine the exact consequences of the directive with respect to the tariff approval competency.

Market and owner feasibility

10.21 The yardstick regulation will improve the sectors ability to attract sufficient funding for future investments. Three keywords are central: efficiency improvements, competition and discretionary power. It will most likely also impact the competitiveness of the specialized supply services via the increased price competition in the DSO sector. The yardstick regulation will improve liquidity of equity and provide for more focused, active and concerned owners. To the extent there really exists a general financing problem for the electricity sector, the yardstick regulation will mitigate or reduce the problem significantly.

Further studies

10.22 The way towards a harmonized regulation includes several in-dept analyses as well as an extensive communication between the grid companies and the regulators. The most important analyses following NEMESYS include:

1) In-dept quantifications of the consequences for the grid companies of changing the regulatory design from the current national regulatory models to the by the working group preferred Nordic regulatory model. The analysis should include quantifications for different types of grid companies as well as an industry-wide quantification. The pilot study should primarily be based on historic data from the ex post regimes in Sweden and Finland, possibly amended with observations from Denmark that lie below the stated revenue cap.
2) Specific simulations should be done to explore the impact of non-profit firms and their strategies on the actual proposal using the exclusion from the reference set. The simulations could use the data above as a starting point, but also extend to take into account various development patterns.
3) Information about the proposal and its properties should be disseminated to all national members and chapters of Nordenergi to ensure that the proposal is well understood and anchored among the membership. The internal debate may improve the approach and facilitate its implementation.

10.23 It is not recommended for Nordenergi to directly conduct studies into the details and parameters of the underlying models, as this might even prolong the implementation. In addition, such action would indicate an inconsistency with the pursued approach, where the regulator is independent in market design, but hands-off in process design.

Concluding remarks

10.24 The NEMESYS proposal is an innovative attempt to design a regulatory approach that improves on the most important dimensions for the Nordic stakeholders, the incentives for investment and efficiency, stable tariffs and quality of service. The proposed approach differs from existing regulation in detail, but primarily in philosophy, as it is a consistently output-based regulation that completely delegates the process to the regulated firms. In doing so, it changes the information requirements in the regulatory approach in the direction of increased attention to what really matters to the final consumer, i.e. a clear and consistent description of the regulated task and how it's performance is assessed. It also constitutes a true paradigm shift in that it restores the role of the regulator to market design and surveillance of structure and development, rather than direct negotiation partner in a proxy-bargaining process on behalf of the customers. Hence, the competition in the NEMESYS approach is played between *firms* in operation using stable and low tariffs at high quality, not towards the regulator using asymmetric information on current and upcoming investments.

10.25 The proposal is advanced in its use of mechanisms (frontier-based yardstick), yet the logic is seducing simple to explain to any stakeholder. Any Nordic customer in the NEMESYS model pays the lowest tariff that any comparable firm offers its clients. Any Nordic firm can define its profit as the difference between its costs and the lowest tariff charged by any other comparable firm. Comparability is defined on measurable dimensions of output, not accounting and process indicators. That's it.

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nemesys

The Nordic Efficiency Model for Electricity distribution SYStems (NEMESYS) aims at developing a common regulation model for electricity distribution in the Nordic region (NordPool region). The project contains three major subprojects:

A) Regulatory System Analysis

Based on an established methodology for regulatory approaches, a careful analysis is performed of the interactions implied by the integrated energy market directives and the degrees of freedom in the institutional and industrial setting in the Nordic countries. This phase also includes a forward and outward looking review of regulatory systems, industry performance and the dynamics of industry development and regulation.

B) Regulatory Mechanism Design

Based on the structured methodology in A, the mechanism design subproject develops a regulation framework that addresses the current and future challenges and that has the potential to accommodate the country specific factors in a systematic and objective manner.

C) Efficiency Model Development

In parallel with A and B, the project performs analysis and development of a performance measurement platform that corresponds to the regulatory standards and information requirements. The process includes estimating the data and processing needs and to demonstrate its applicability in the entire region using representative industry data. The model explicitly addresses the horizon, investment and quality dimensions of the service, in addition to operating cost and task complexity.

The NEMESYS project is commissioned by Nordenergi and staffed by SUMICSID AB as project coordinator and EC Group AS, Gaia Group OY, SKM Energy Consulting AS and RR Institute of Applied Economics as project partners.

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