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NEMESYS Subproject B: Regulatory Mechanism Design

FINAL REPORT

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nemesys

Disclaimer

This is the final report for the subproject *Regulatory Mechanism Design* within the Nordic Efficiency Model for Electricity distribution SYStems (NEMESYS) project commissioned by Nordenergi under coordination by SUMICSID AB. This report has been coordinated and edited by prof. Peter Bogetoft, SUMICSID AB, with contributions from prof. Per Agrell, SUMICSID AB Jørgen Bjørndalen, SKM Energy Consulting, and Mikko Syrjänen, Gaia Group OY.

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Summary

This third interim report from the NEMEYS project on the Nordic Regulation Model is devoted to Mechanism Design. The subproject first provides an overview of the regulatory tool box and general criteria to evaluate the pros and cons of different regulatory approaches. The subproject next focuses on three aspects that have been identified as particularly important in connection with a coordinated regulatory effort at a Nordic level, viz. quality regulation, asset evaluation and harmonization alternatives. The combined effort leads to a multiple criteria evaluation of three regulatory approaches, denoted ALFA, BETA and GAMMA. The most promising of these will be analyzed in more details in subsequent phases of the project by including also more thorough projections as to the consequences of the proposed approach for regulators, firms and EU.

The report is by nature somewhat technical and not primarily intended for back-to-back reading. The purpose is to provide a sufficient theoretical background for the choice of the most interesting regulatory approach that will then be defined in more details and discussed from a more practical point of view in subproject E. A reader interested in the choice of development path should primarily concentrate the reading to the chapters with direct bearing on the decision, i.e. 2, 7-8. Chapters 3 and 4 are addressing specific issues related to regulatory design of quality, assets valuation and capital costs. Chapters 5 and 6 are in-depth descriptions of the fundaments and workings of the methods ALFA-BETA and GAMMA, respectively.

This report constitutes a supplementary deliverable, upon which the final report of the NEMESYS project will be based.

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1. Introduction

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).

The goals of the study are to:

- 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.
- Identify the most critical factors in cross-border regulation and benchmarking
- Propose a common model for regulation and benchmarking of electricity distribution companies.

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.

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

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

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

This interim report is released as a supplementary delivery. It presents the result of the Subproject B on Mechanism Design. This subproject departs from the insight of Subproject A on System Analysis and Subproject C on Efficiency Model Development. In particular, this subproject continues and refines the discussion of alternative harmonizations and critical success factors from Subproject A and the results as to data harmonization and quality inclusions from Subproject C. Part of the contents in this report are intended for inclusion in the Final project report from subproject E, Synthesis.

Authorship

The editing of the report is coordinated by prof Peter Bogetoft (coordinator, SUMICSID AB) and includes contributions by prof. Per Agrell, SUMICSID AB, Helle Grønli (EC Group AS) and Mikko Syrjänen (Gaia Group OY) in alphabetic order.

Outline

This subproject first provides an overview of the regulatory tool box and general criteria to evaluate the pros and cons of different regulatory approaches. The subproject next focuses on three aspects that have been identified as particularly important in connection with a coordinated regulatory effort at a Nordic level, viz. quality regulation, asset evaluation and harmonization alternatives. The combined effort leads to a multiple criteria evaluation of three regulatory approaches.

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 continues with an analysis of quality regulation. Chapter 4 next discusses in more details two important elements of regulation that are often neglected in consultation documents, namely asset evaluation and capital costs. Chapters 5 and 6 expand on two of regulatory packages that seem particularly interesting if the attempt to develop a common regulation should be based on state-of-the-art rather that the least common denominator, viz a DEA based yardstick regulation and repeated concession auctions. We continue in Chapter 7 by assessing alternative ways to harmonize the DSO regulation in the Nordic countries. The report concretizes in Chapter 8 where three more specific alternatives are formulated and evaluated. Based on consultations with the Working Group, one of these will be selected and more thoroughly analyzed in the final subproject E.

2. Regulatory tool-box

2.1 Regulatory economics

Regulation economics was long considered as a fairly uninteresting application of industrial organization. Early regulatory theory largely ignored incentive and information issues, heavily drawing on conventional wisdom and industry studies. This kind of institutional regulatory economics was challenged already in the seventies with economists as Friedman, Baumol, Demsetz and Williamson questioning the organization and potential restructuring of natural monopolies. However, the main breakthrough came in the late eighties with information economics and agency theory (Holmström, Laffont, Tirole). An authoritative reading in the area is Laffont and Tirole (1993). Contemporary economic theory pursues the private goals and strategic behavior of the individual agent, with particular emphasis at the access, cost and use of information. The practical applications from this stream of research have had a profound impact on modern markets, market instruments, contracts and economic restructuring.

Why regulate?

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.

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.

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

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 customers' and the firms' utility (profit) and the 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).

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 market 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 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

While much of the economic literature stress the regulation via compensations and reimbursements, must regulators also interferes much more directly in the operations of the firms. This corresponds to the dual use of price and restrictions, or soft and hard constraints, as they are commonly introduced in the literature on intra-firm coordination. In an abstract sense, the use of restrictions is just a version of a price based regime with large penalties for certain undesirable behavior. In reality however the two approaches may have significantly different effects when asymmetric information is introduced.

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 hit-and-run on behalf of the firms. Generally, the regulation is extensively process-oriented and suffers from problems of technology lock-in with time.

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. 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 nets. If concessions are awarded based on lowest price subject to an ex-post level of service (coverage, failure rate, etc.), a hit-and-run firm can win the contract by neglecting investments and then cease to exist when the damage is observed. To limit this risk, regulators demand frequently the posting of a bond to offset the consumers' risk. In economic theory, this *bond* is called the hostage and could sometimes be substituted for shares of stock, assets or other (profitable) concessions.

Dynamic regulation

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

Many other industries with natural monopolies depend strongly on large and very specific capital investments. This makes such industries amenable to hold-up problems 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.

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 capturing information rents and leading to low short-run consumer tariffs may in practice be associated with risks of halting process innovation, improvement and management recruitment.

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.

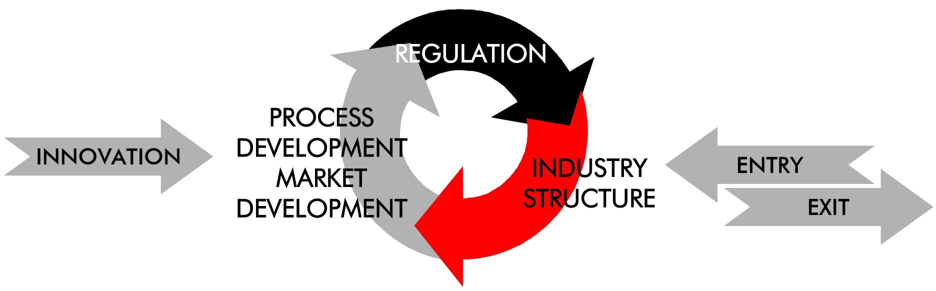

Figure 2-1 Dynamics

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.

This all 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.

In Chapters 3 and 4 we expand on the two most advanced packages, the Yardstick regimes and the Concession auctions regimes.

The choice of mechanisms varies between country, between sectors within a country, and over time in a given sector and country. These variations are not unlike what can be seen in other industries, e.g. in the area of agro-business contracting, cf. Bogetoft and Olesen (2004). The variations may also be perfectly rational reflecting variations in the objectives and the possibilities. In the final section we will discuss some multiple objectives in regulation and we will discuss some ideas of regulatory dynamics. Together, this should provide a set of *criteria* against which different regulatory approaches and changes herein can be evaluated.

2.2 Elements

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.

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 setting are considered given.

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.

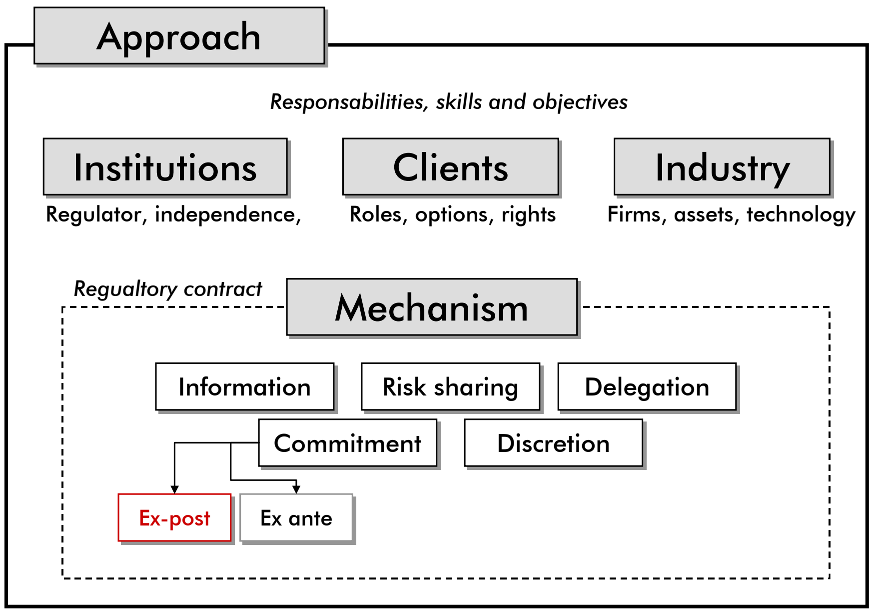

Figure 2-2 Regulatory approach, institutional design and mechanism design.

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 makes 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

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

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 rent that is left to the provider.

Discretion

Discretion/automatics are two extremes on an interval of regulatory enforcement. A mechanism that proscribes 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 rent to participate in the mechanism, fearing arbitrary expropriation of rents. 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, which is called bureaucracy in economic theory.

Delegation

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

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

Consider a general mechanism for a regulator and a firm over two periods. The regulator has the opportunity to use some information x_0 about the agent (ex ante) and/or to observe some information x_1 from other agents in the next period (ex post). The regulator may now propose the following contract for the first period:

$$R = c_1 + \rho[c(x_0,x_1) - c_1]$$

Incentive power

In the model above, we call ρ the incentive power. For a *high-powered* contract, let's say $\rho = 1$, the firm receives $R = c(x_0,x_1)$ 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 all interest to reduce its own costs c_1. On the other hand, if the regulator has poor information x_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., cost-plus. 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 x_1 that at least limits the inefficiency to some upper bound, which is the case in reality.

Ex-ante / Ex-post

In an ex-post regulation, the regulator would freely use the information x_1 to decide how much to pay the firm. Depending on how x_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 $c(x_0,-)$. Clearly, the ex-ante regime in its pure form is only interesting with high-powered regimes, as the final cost cannot be used for the reimbursement.

The Nordic countries have rather many and small distribution mixed-ownership monopolies with 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 in 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 two-level models.

2.3 Classical packages

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 four types of regulatory mechanisms here, namely

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

Cost-recovery regimes

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

$$R = C^{OpEx} + D + (r + \delta)K$$

where C^{OpEx} 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 credit costs of investments with similar risks and δ is a mark-up.

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).

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.

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)

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_g 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

$$R_i(t) = C_i(0)(1 - x - x_i)^t \quad \text{for } t = 1,..T$$

where $R_i(t)$ is the revenue in period t, and $C_i(0)$ is the cost of firm i in 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.

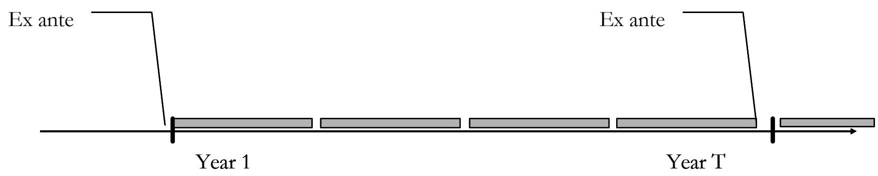

Figure 2-3 Ex ante revenue cap

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, which limits the efficiency incentives. 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.

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

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 $j = 1,..,i-1,i+1,..n$ operating under similar conditions

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

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.

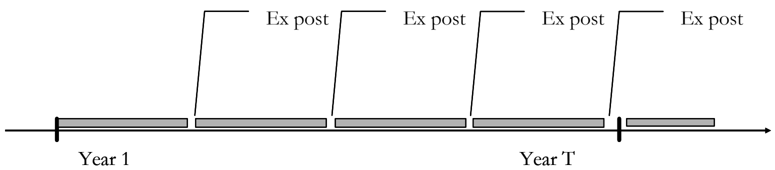

Figure 2-4 Ex post revenue cap

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.

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.

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) auctions regime

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 projects demands C_i , $i = 1,..n$ we may award it to the bidder i with the lowest bid $C_i = \min_j C_j$ and compensate him

$$R_i = \min_{j \neq i} C_j$$

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.

Problems are for limited markets with high concentration that bidding may be collusive, that excessive informational rents may be extracted and that competition may be hampered by asymmetric information among incumbents and entrants (McMillan, 1992). Even under more favorable circumstances, the problems of succession and investment incentives remain to be addressed (Williamson, 1976). In the energy sector for example and 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.

We shall expand on the franchise auction idea in Chapter 3 where we study how one can integrate with advanced benchmarking techniques to cope with differences in the projects offered in a one shot procurement setting. Also, we shall discuss the problems of successions and how prices can be set for the capital installations of a losing incumbent.

Technical norm models

At large, there are 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, save for simplistic models that add a restrictive structure to the function (linear with ordinary least squares regression). 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.

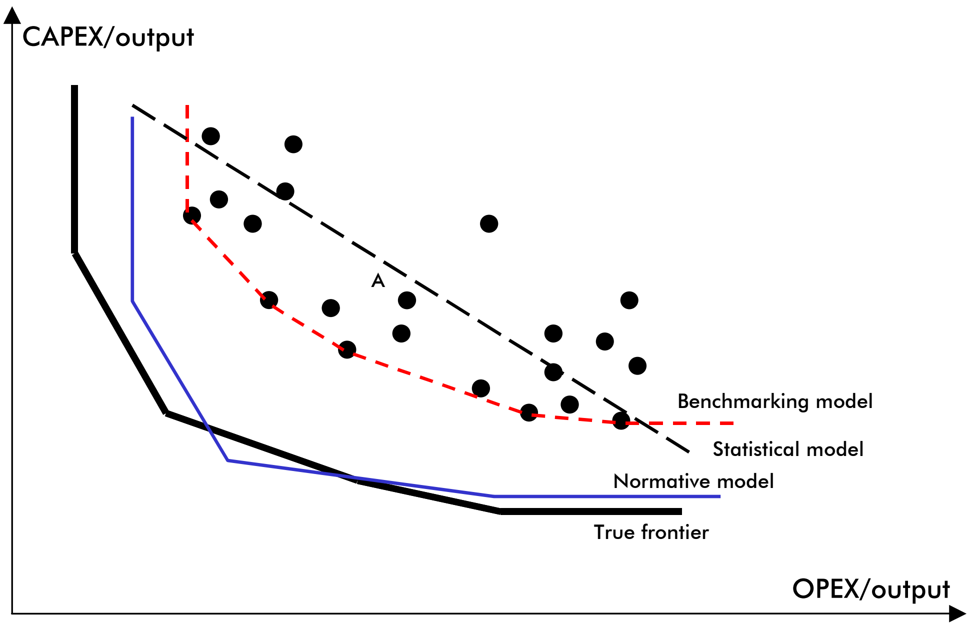

Figure 2-5 Production space and normative, statistical and benchmarking models.

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*.

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.

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).

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 (STEM, 2005). 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 is 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

Before closing the discussion of these schemes to regulate the overall compensation, we emphasize that most regulatory systems involve a mixture of many elements. To balance the effects of information distribution and availability, risk and market structure, regulatory systems are the results of compromises between multiple socioeconomic objectives.

Also, the elements of the regime, the institutions and the market structure are interdependent and often endogenously decided, a fact that is often neglected in regulation studies. Thus, a strong centralized industry structure, sign of large asymmetry of information, is often combined with a formalistic institutional solution with weak incentives to limit rents without requiring much interaction. A well-balanced pool of competing firms with limited asset investments often coincide with a strong regulatory institution with short-term high-powered contracts, as the regulator can use and trust the information acquired to limit rents.

2.4 Criteria

Real regulation systems balance a number of conflicting objectives taking into account several aspects of the situation. Regulation theory provides useful insights but the formal models used in the theory tend to focus on a few effects in stylized environments. The risk of a partial approach is that while improving one aspect of a regulation, new and more serious problems may arise in other aspects. Practical, theory based regulatory design can therefore benefit from a more holistic, systemic approach. We develop the approach in this section and illustrates its usage in later chapters.

The *systematic approach* to the choice of a regulatory system is based on the basic economic notion of rationality. The elements of this framework are the objectives, the means, the contexts, as well as the performance of different means according to different objectives in different environments.

Having provided the framework and having covered the basic means and objectives, we investigate in more detail how they interact. We do so by discussing *10 principle concerns in regulatory design* that can be derived from the theory and practice of contracting and regulation.

Rational ideal

Rationality is the basis of most economic disciplines. The idea is to look at choices as the result of a systematic search for the alternative that provides the decision maker with the highest possible utility. Ideally, therefore, rational choices are the solutions to optimization problems

$$\begin{aligned} &Max\ U(a,s) \\ &s.t.\quad a \in A \end{aligned}$$

where *U(.)* is the utility function, *a* is a specific alternative, *A* is the set of alternatives, and *s* is the specific context (state) of the decision maker. Using this framework to regulation we would interpret

A = set of possible regulatory schemes

a = a specific regulatory scheme

s = a specific context

U = the social value of using regulation *a* in the given context *s*

In reality, the specific context may of course affect the overall objective as well as the set of alternatives. Thelatter can however be technically accommodated under the objective since non-feasible alternative may be toughed of as generating sufficiently unattractive objective values.

At a theoretical level, the rational choice provides an approach to chooses among alternative regulations. It also provides a approach to evaluate alternative regulations. Regulation a' is more attractive than a" if it generates higher social value, i.e. if $U(a',s) > U(a'',s)$. Also, for appropriate social value functions *U,* the efficiency of regulation *a'* can be summarized as the actual social value compare to the highest possible social value, i.e. $U(a',s)/Max\{U(a,s) \mid a \in A\}$.

Rational practice

From an applied perspective, the rational choice approach provides a recipe. To make systematic, comprehensive and theoretically sound evaluations, we must identify more precisely the social value function, the set of alternatives and the context. Next we must evaluate the performance of alternative regulations according to the described values.

In an applied setting, we cannot hope to identify the ingredients in all details, but the attempt has proved useful in numerous applications. We take the first steps towards an identification of the ingredients here, and we expand our identification using different lines of theory and empirics as we go along. We summarize our (preliminary) findings is Chapter 6. It is important to emphasize, however, that the appropriate objectives and means cannot be identified in a vacuum and detached from the specific context. A refinement of our analysis would involve interaction with interest groups, most notable the regulator and the firms, in a subsequent (post-) project.

In an applied setting, the must complicating aspect to identify is usually the social value function U and possibly the relevant context s. Both difficulties can however be dealt with using a multiple criteria approach, cf. Bogetoft and Pruzan (1991).

Using multiple criteria, one identifies a list of objectives that contributes to the overall social value. This means that the set of criteria should ideally be *complete*, so as to cover all important aspects of the problem, *operational*, so as to be understandable to the stakeholders, *non-redundant* so that double counting of impacts can be avoided, and, closely related, *minimal* so that a problem's dimension is kept as small as possible. Furthermore, we would like them to be at least somewhat *independent*, so that at least the ranking of the values of one criterion is unaffected by the value of the other criteria. We observe that the criteria are usually somewhat *conflicting* in the sense that we cannot improve one criteria without deteriorating one or more of the others.

A useful list of criteria can usually be constructed by relying on theory, discussion with stakeholders etc. and by organizing the criteria in a *hierarchy*. At the top, we have the overall, all-inclusive reason or reasons for caring about the problem in the first place, say to improve social value. As we move down the hierarchy, we successively clarify the meaning of higher-level objectives by subdividing them into lower-level objectives and criteria of more detail. Also, one may look at lower objectives as the means to the higher objectives, which can be viewed as their ends. Every time we subdivide, we must be careful to have all facets of the higher level objective accounted for by one of the lower-level objectives. In this way, each level of the hierarchy ideally provides a complete, comprehensive description of the possible concerns.

We shall illustrate some of these steps below, but we emphasize that a full-scale application of this approach would require the explicit and active involvement of the relevant stakeholder, including the regulator and the firms. This may be a topic for future projects, workshop etc.

It is also worthwhile to note, that the multiple criteria approach can be used to cope with uncertainty about the specific setting. If the precise nature of the present - or future ! – context is unknown, as it usually will be, a useful approach is to identify a set of possible scenarios S and to look for regulatory approaches that are doing well in all settings. This can be formalized as seeking to maximize U(.,s) for all possible s in S.

To summarize the multiple criteria approach to regulatory evaluations, Table 2-1 below is useful. The rows list the relevant criteria contributing to the overall social welfare. The first column represents different regulations and the cells give qualitative or quantitative indications of the performance of the different regulations according to the different criteria. The final column represents the context and indicates the relative importance of the different criteria in the specific context. The aim of the regulatory design is thus to find the column that is doing rather well according to the criteria that are particularly important in the given context.

Table 2-1 Systematic multiple criteria evaluation

		Regulatory Approach		
Criteria	Mech 1	....	Mech *k*	Context
Criterion 1	*Good*	.....	*Good*	Important
Criterion 2	*Ok*	.....	*Very good*	Very Important
.....	.....	.....	.....	.....
Criterion n	*Very good*	.....	*Ok*	Important

Criteria

To develop a comprehensive list of relevant criteria, it is useful to think in terms of *coordination*, *motivation* and *transaction costs*. Most problems of economic design can be cast in this setting, e.g. Milgrom and Roberts (1992).

All economic systems – except simple Robinson Crusoe systems – involve several agents with conflicting interests, private information and private possibilities to act. From the point of view of specialization, one can even argue that the decentralization of information and decision-making among different agents is what gives a system the potential to operate more efficiently than a single individual. Specialization however comes at a cost. Information must be shared and actions must be coordinated. There are three aspects of this:

- **Coordination:** ensure that the right services are produced at the right time and place.
- **Motivation:** ensure that the parties have individual incentives to make coordinated decisions.
- **Transaction costs:** ensure that coordination and motivation are provided at the lowest possible cost.

A mechanism (cf. 0) must 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.

It is well known that these overall objectives may conflict. To ensure private motivations, we may for example have to forgo the optimal coordination that is possible in a world, where all agents have the same interests. The different objectives must therefore be *balanced*, and an important task is to clarify the necessary trade-offs.

We may distinguish several regulatory objectives are mentioned as a prerequisite for a social optimum, cf. ECON (2002). They include

- Short-Run
  - Optimal use of production capacity
  - Optimal balance between electricity, other sources and carriers, and demand reduction
- Long-Run
  - Correct net and production capacity
  - Optimal balance between net investments and reallocation of consumption and production over time and space
- Structural development
- Appropriate return on investment
- Lowest possible regulation costs
  - Costs at regulator and firms of implementing the regulation
  - Costs from lack of stability and strategic behavior
  - Costs from changing a regulation model

We see how these criteria refer mainly to the coordination aspects in the short and long-run, at the individual as well as the sector level. The motivation aspects are present in the required return on assets and the costs of strategic behavior. Finally, the transaction costs are indicated in terms of the implementation costs and the costs of changing the model.

In the regulation literature, one can find other more or less elaborate listings of properties that characterize good regulatory mechanisms. Pfeifenberger and Tye (1995), for example, discuss a number of pitfalls in different types of incentive mechanisms. They argue that a proper incentive mechanism should: (1) be simple, (2) provide proper motivation, (3) be fair, and (4) have staying power. Simplicity is required to reduce the administrative burden on regulators and to find acceptance in the public. The mechanism should induce cost minimizing behavior. To ensure fairness both customers and utilities should perceive benefits from the mechanism. Staying power of a mechanism ensures time consistent signals.

Pfeifenberger and Tye (1995) also give a number of recommendations for regulators. Firstly, the rewards and penalties should be restricted to the operationally and politically acceptable alternatives. Secondly, the annual rate increase should be constrained to avoid “rate shocks” that may cause public distress. Thirdly, the problem of restart and review processes should be addressed up front. This must ensure that both regulators and utilities are committed to mechanism. Fourthly, to avoid skewing management attention it is very important to design the mechanism with balanced incentives and to choose a proper measurement of outputs. For example, the output measurement should take into account for the quality. Also, the output measure must take into account for the multi-product character of most industries

2.5 Ten rules

A recent attempt to combine the theory and practice of contracting is Bogetoft and Olesen (2002). Drawing on a careful reading of the contracting theory and a study of numerous actual contracts, they arrive at a checklist with 10 different rules of thumb that can support such an approach. The 10 rules covers what they have found to be particularly important aspects of coordination, motivation and transaction accost considerations.

Following a similar route, we offer here a list of ten principal concerns in regulatory design as given in Table 2-2 below:

Table 2-2 Ten rules of contracting

	Concern	Focus
1.	Coordinate production	Coordination
2.	Balance the pros and cons of decentralization	
3.	Minimize the costs of risk and uncertainty	
4.	Reduce the costs of post-contractual opportunism	
5.	Reduce the costs of pre-contractual opportunism	Motivation
6.	Do not kill cooperation	
7.	Motivate long-term concerns	
8.	Balance the pros and cons benefits of renegotiation	Transaction costs
9.	Reduce direct costs of contracting	
10.	Use transparent contracts	

In Table 2-2 we have grouped the ten rules in three categories corresponding to the overall objectives of coordination, motivation and minimization of transaction costs. This categorization is not unique. The grouping simply reflects the primary intention of the (class of) tools considered. We emphasize that all tools have implications for all objectives. That is, when a given tool is applied, it will almost always have (adverse) effects on the other objectives. An incentive scheme to improve motivation may for example at the same time be costly from the point of view of coordination and transaction costs as it may lead to sub-optimal risk-sharing as well as costs of writing and administrating the contract. We will emphasize the trade-offs in the discussions below, where we investigate how these concerns interacts with the different tools available to a regulator - and in particular the regulators possibility to rely more or less on ex ante and ex post schemes.

Coordinate activities

Perhaps the most important role of regulation is to coordinate the actions of independent decision-makers. After all, the reason to cooperate is to create values through joint actions. Coordination must ensure that the production and investments are optimized throughout the entire production chain. Lack of coordination leads to sub-optimization where decision-makers "optimize" their own decisions without considering all the consequences they have, for other decision makers in the production chain. Coordination can generally be achieved using instructions, or price signals or some combination of the two. It is often attractive to coordinate qualitative aspects as well as matching and synchronizing problems via instructions and quantitative aspects via prices. See Milgrom and Roberts (1992) for detailed discussions of the coordination aspect in contracts.

Balance the costs and benefits of decentralization

The allocation of decision rights is a key aspect of a regulation. A regulation of distribution may be more or less centralized with more or less decisions undertaken by the regulator. Theory suggests, however, that the parties should aim for to have decisions made by the most informed party. Following this principle, there are two immediate benefits of decentralized decisions. It reduces the risk of important information being neglected and the need for costly communication. On the other hand, a decentralized organization may increase the risk of uncoordinated decisions making and may create matching and synchronizing problem.

Decentralizing the decisions may create motivation problems. If a contract delegates the decision rights to the firms, the contract must design the incentives to alleviate the moral hazard problem. On the other hand, centralized decision-making can promote opportunistic behavior by the regulator, e.g. hold-up problems. The costs and benefits of decentralized decisions are summarized in Table 2-3 below. A plus (+) in this table indicates that the choice (decentralization or centralization) has a positive impact on the problems listed in the first column.

Table 2-3 Pros and cons of decentralization

Problem	Decentralization	Centralization
Use all important information	+	
Reduce costly communication	+	
Coordination		+
Information requirement	+	+
Moral hazard		+
Hold-up	+	
Reduce information rents		+

The coordination and decentralization aspects should not be underestimated. Much of modern regulation theory stresses the incentive problems and the limitation of informational rents via relative performance evaluation etc. In our view, these issues are still only (important) side constraints to the overriding task of making sure that the different agents take individual decision and work together appropriately. This means that one of the more important aspects to investigate is the allocation of decision rights and design of information flows that facilitates a reasonable systems wide behavior.

The choice of a more or less centralized regulation also interacts directly with the question of ex ante versus ex post regulation. To the extent that a centralized solution is called for, for example because of the need for synchronization, the existence of system synergies and externalities, sequential use of information via an ex post regime will be less attractive.

Indeed, recent insights in capital budgeting, where multiple projects compete for scarce resource, suggests that periodic, holistic adjustments may be attractive, cf. Antle et al. (2000). Smaller adjustments to local variations are more suitable for sequential use of new information.

Minimize the costs of risk and uncertainty

Risk is prevalent in the distribution sector as in most parts of the economy. The companies and consumers are subject to external risk from weather, labor markets, capital markets etc. In addition, the parties are subject to behavioral risk, as they do not know the behavior of the other parties. We normally consider economic agents as risk adverse such that an uncertain revenue (payment) is considered less valuable (more costly) than a certain payment with the same expected value. The parties can reduce this cost of risk and uncertainty in two ways. They can minimize the risk and they can share the risk between them.

They can minimize the risk and uncertainty in different ways. One way is to choose a robust payment plan that leads to reasonable outcomes even if the initial assumptions do not hold true. Information collection (monitoring) is another way. Also, the parties can reduce the measurement errors through refined measurement techniques and statistical analysis.

Risk sharing depends on the relative risk aversion of the parties and interacts with incentives. If the companies are risk averse and the consumers – by the small budget used on distribution anyway – are risk neutral, the efficient way to share risk is to place all the risk on the consumers so that the companies basically gets a fixed payment. However, to motivate the distributors to take unobservable actions, the payment must depend on the output. An efficient contract balances the costs of risk bearing against the incentive gains, cf. Holmström(1979). On the other hand, if the companies are risk neutral and the consumers are risk adverse, the consumers should ideally pay a fixed amount. Again this may conflict with motivation since the consumers will now have no incentive to adjust their behavior. In general, we note that there is no trade-off between incentives and the sharing of common risks affecting all producers equally. By using relative performance evaluations rather than absolute ones, one can eliminate common risk from the payment to the companies, cf. Holmström(1982).

Risk sharing and the ability to adjust payment more closely to the sequential events is an important aspects of the ex ante vs. ex post discussion. It is worthwhile emphasizing, therefore, that *even if the companies are more or less risk neutral, relative performance evaluations (benchmarks) are useful* since it allows a more precise inference about the firms behavior and hereby the ability to provide more high powered incentives without affecting the costs of risk. Consequently, more coordination is possible at given costs. Assume for example that the firm is risk neutral and that an attractive investment only shows up randomly via the observation of some variable with values H or L, depending on the firm's behavior as indicted in Table 2-4 below.

Table 2-4 Systematic multiple criteria evaluation.

	Observation		
Effort	L	H	Costs to firm
Low	½	½	0
High	½+ a	½'-a	1
Payment	P_L	P_H	

The firm in this case will supply maximal effort only is

$$(½+a)p_H+ (½-a)p_L \ -1 \geq \ ½p_H+ ½p_L - 0$$

i.e. only if

$$p_H-p_L \geq 1/a$$

Hence, the incentive power, p_H-p_L , decreases when a increases. In other words, with a good information system, possibly because the common uncertainty has been eliminated via a relative performance evaluation, the incentive power can be smaller. This is attractive since the random variation in payment is costly to the consumers if not to the firms. To summarize, if the firms are risk neutral and the consumers at least slightly risk averse, it is attractive to improve the behavioral inference via design of better information systems, by making relative performance evaluations etc. This is so since the payment variations needed to motivate a certain behavior that cannot directly be observed. It is increasing when the quality of the information system deteriorates. The payment variation is not attractive to the consumers.

Reduce the costs of in-period opportunism

Opportunistic distributors do not automatically take the actions called intended by the regulator, i.e. moral hazard problems occur. The regulation should motivate the companies to take the right actions, even if they are unobservable. The contracts must respect the incentive compatibility constraint, which states that the producers choose the actions that maximize the producers' own utility.

In order to provide incentives for unobservable actions, the compensation must be based on outcome. However, usually there is a stochastic relationship between the actions and the resulting output. This implies that output-based incentives will expose the companies to risk, because the payment depends on factors outside the producers' control, e.g. the weather. When the producers are risk averse, this risk carries a risk premium. Hence, there is a trade-off between providing incentives and minimizing the cost of risk, cf. above.

If the regulator can obtain better information about the companies' effort, he can expose them to less risk – and still induce them to take the same actions. According to the informativeness principle, any performance measure, which reduces the error in estimating the producer's actions, should be used in the contract, cf. Holmström(1979). This implies that the payment to a distribution company should depend on information about the performances of other companies, if this gives a more precise estimate of the effort provided by the company in question (e.g. due to common risk).

The important conclusion about risk allocation and in-period incentives that can be derived from the preceding paragraphs are, that we always need to make the best possible inference about the behavior of the companies using the available information. In the case of risk adverse firms, we need finer inference to reduce the risk they are exposed to. In case of risk neutral firms, we need it to reduce the risk that the consumers will be exposed to while providing incentives.

Reduce the costs of between-period opportunism

When a company has private information about its skills, cost structure etc. it may try to use this in the commitment and settlement negotiations before a new regulation period. In general, it will be able to obtain conditions that provide expected profit above the reservation value (i.e. it earns information rents) by taking advantage of the regulator's hesitance to have the regulation rejected and the firms quit. This is the problem of pre-contractual opportunism or adverse selection. See Akerlof (1970), Salanie (1997) or Milgrom and Roberts (1992) for detailed analysis of pre-contractual opportunism

The literature on contract theory points to at least four ways of reducing the adverse selection problem. Firstly, the regulator can collect information before designing the new conditions. In this way, he can reduce the companies' informational advantage. Secondly, the companies can use signaling – or the selection from a menu of contracts, to reveal their true type through their behavior before a new regulation is determined. Thirdly, for some aspects like quality, the regulator can use rationing, i.e. offer conditions that is only acceptable to some ("good") company types. This reduces companies' abilities to extract rents by mimicking worse types. Hence, rationing leads to fewer but better contracts in the sense that some adaptation of behavior, e.g. quality improvements, is forgone for some companies to save on the rents that other companies can charge. Last but not least, the regulator can undermine the private information of the companies and their ability to extract rents by relying less on the pre-regulation (a priori) information and more on information in period (ex post) information. We shall expand on this below.

Do not kill cooperation

The parties can only achieve the full economic benefits if they cooperate. The companies can help each other by sharing know-how, exchanging favors etc. Flexibility from both regulator and the companies may enable them to adjust to events not accounted for in the contract. Hence, it pays for the parties to work in a cooperative spirit where changes can be made without costly negotiations or conflict resolution.

Relative performance evaluation may have a negative impact on the cooperation between producers, cf. Lazear (1989). This is particular obvious when the negative impact on one company from the improved performance of other companies is immediately like in an ex-post regime with sequential updating. On the other hand, the immediate effects of changed behavior may also support coalition making among the companies (much like an oral auction makes coalitions easier by the possibility of more or less instant punishment for breaking a cartel, cf. also cooperation in repeated oligopoly market, cf. Laffont and Tirole (1993).

Using strong incentives may also complicate the cooperation. For instance, a company in a high-powered quality contract may protest when the regulator changes his conditions since this adversely affects the producer's payment. Often, the companies have better information about the conditions and behavior of other companies. Group incentives, where the total payment to a group depends on the performance of the entire group, may motivate the companies to assist and monitor one another and perhaps impose some kind of social penalty (e.g. a bad reputation in the neighborhood), cf. Milgrom and Roberts(1992).

Motivate long-term concerns

The regulation should induce the parties to take the long-term effects of their actions into consideration. Electricity distribution requires large capital investments that are rather location specific and which has lower value in alternative uses. Such, so called specific investments, are particularly sensitive to the ability to make long-term commitments. A company that has invested in specific assets is very vulnerable to changes in the regulation. This leaves the company in a weak bargaining position in (re-)negotiations after the investment has been made. Of course, the companies foresee this and will therefore be more reluctant to make specific investments. This is the hold-up problem.

The hold-up problem can be reduced in different ways. Firstly, long-term regulation – and in particular the use of ex ante terms settled for a relative long regulation period, reduces the hold-up problem because the terms are settled before the companies make specific investments. In practice, however, it is impossible for the parties to make complete contracts that cover all possible events. This makes hold-up possible even in long-term regimes.

The role of reputation may also prevent the parties form holding-up the other party. A clever regulator with a good reputation may be reluctant to devalue this reputation by holding-up the companies, because it will ruin the regulator's chances to make good settlements in the future – with the present or even with new firms. It is well known from the theory of incentives that reputation has to be earned and takes considerable time to build up. It is however very fast to milk. Most likely, the planned use of sequential information in an ex post regime, may actually increase the ability to make long-term commitments. It is not likely that a fixed, long-term contracts, can survive when conditions changes dramatically and it may therefore be better to foresee this and plan possible renegotiations in an ex post regime. The minimal and maximal return on assets stipulate in the Norwegian model may serve precisely to increase the regulator's ability to make long term commitments, since dramatically high or low profits, that could put him under political or industrial pressure has already by coped with. (In the same spirit, old very long English tenant contracts were improved by including mediation institutions.)

Long-term a priori settlements can also alleviate ratchet effects, i.e. the tendency to under-perform in early periods to avoid tough conditions later on. This however requires a reasonable long regulation period and a somewhat uncertain review before the next period.

Balance pros and cons of renegotiation

Renegotiation enables the parties to adjust the regulation to changes in the environment. Hence, the parties can remove ex post inefficiencies through renegotiation. However, renegotiation also reduces commitment and may lead to strategic behavior. See for example Williamson (1996), Hart (1995), and Milgrom and Roberts (1992) for some analyses of the pros and cons of renegotiation.

If the parties know that the conditions will be renegotiated, they may not act according to the incentives in the initial regime but according to the incentives they expect to receive in the renegotiated regime. Hence, ex post renegotiations, and the associated problem of forgiveness, can lead to ex ante inefficiencies. Often powerful incentives rely on harsh penalties that are costly for both parties to implement, i.e. ex post both parties can be better off if the penalty is removed. If the parties foresee this as the result of renegotiation, the incentives will be weakened. The trade-off between risk sharing and incentives demonstrate this. If the parties renegotiate after the effort has been provided, the parties can improve the ex post efficiency by shifting the risk from risk averse to the risk neutral However, the incentives vanish if the producers expect this to happen.

Reduce the direct costs of regulation

The direct costs of regulation are the time and money spent on information collection, monitoring, bargaining, and conflict resolution – i.e. the costs of running NVE. It is important to reduce these costs because they do not directly generate a surplus – on the other hand, they are important activities as they provide the information required for well-coordinated decisions. Milgrom and Roberts (1992), Williamson (1996) and Hansmann (1996) analyze the direct cost of contracting.

From the point of view of the direct costs of regulation, it is clear that ex post regimes with sequential use of new information and possibly some (re-)negotiations along he way, is quite a bit more demanding.

Use transparent regulation

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.

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.

2.6 Conclusions

In this chapter, we have provided a survey of state-of-the-art in regulation of local monopolies.

The regulator's problem is basically one of asymmetric information, and the main challenge in regulation is to cope with this asymmetry in a reasonable way. On the one hand, the regulation should not leave the DSOs with excessive rents and limited incentives to innovate and consolidate. On the other hand, the regulation should ensure fair rates of return and protected the DSOs against arbitrary and misinformed decisions by a regulator.

Three of the five approaches rely on the possibility to undermine the informational advantages of the DSOs via relative performance evaluations of past and/or future performances. This means that the choice of mechanism also involves the choice of one or more benchmarking approaches as discussed in Subproject C. The two other approaches, the cost recovery approach and the technical norms approach rely more on accounting and engineering principles, respective, to deprive the DSO from their superior information.

It is theoretically difficult and certainly not very useful in practice to talk about an optimal regulation. Any regulation must solve a series of problems and can therefore best be evaluated on a multiplicity of criteria. We have outlined the main ones above, both in terms of the general problems of coordination, motivation and transaction costs economics, and in terms of some rules of thump that have been derived from combinations of theory and practice.

In the following chapters, we shall analyze some of the regulatory issues in more details and propose new regulatory approaches. This process culminates in chapter 8 where we define 3+1 most interesting alternatives and make thorough multiple criteria evaluations of these. This forms the basis for our recommendation of one alternative to be defined and analyzed in more details in Subproject E.

3. Quality regulation

Regulation in theory as well as in practice has mainly focused on the prices of goods and services, e.g. the prices for having electricity distributed. Price however is just one important parameter in the relationship between firms and customers. Quality is another. After all, it defines the good being exchanged and it makes little sense to set prices on ill-defined products. In this chapter, we outline some fundamental issues and challenges in quality regulation and we sketch some operational solutions. The chapter can also be read in conjunction with Subproject C, Chapter 3, where the operationalization of quality measurement in regulation is addressed.

3.1 Regulatory issues

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.

Optimal quality level

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 2-6below. Here the cost function is the cost to the firm of changing its present quality level. The benefit function B(q) is similarly the gains to the consumers from changes in the quality level. The optimal level leads to the largest difference between costs and benefits

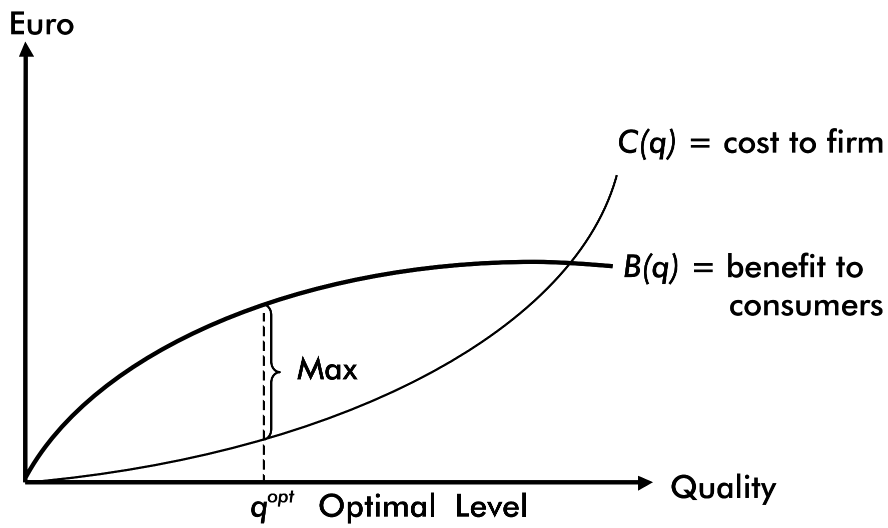

Figure 2-6 Optimal quality level

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Information and Strategic Behavior

In reality the regulator knows neither costs nor benefits a priory. 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.

Regulatory Phases

The tasks involved in attempting to solve 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

We shall now discuss some important decisions to be made and some useful tools to support these phases. We start with the technically easiest parts, namely the choice of principles and the implementation of given quality levels. Only then do we return to the information collection and choice problem. This is where the main problems of asymmetric information and strategic behavior is hidden.

Quality dimensions

The quality property is seldom single dimensional. Rather, quality has several dimensions and different dimensions may call for different regulatory mechanism.

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

- Reliability of supply
- Voltage quality
- Commercial quality

Numerous indicators can be used to measure these quality dimensions, cf. CEER(2001). Reliability is 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 or non-verifiable attributes of quality

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. On the other hand, one should – contrary to traditional wisdom - not exclude the use of more subjective, *non-verifiable indicators per se*. Even a subjective ranking by the regulator or a group of consumer representatives could play a role in the regulation. To avoid that the non-verifiability property is misused, one must simply ensure that the evaluators cannot gain by misrepresenting their private information. One way to ensure this is by tournaments with a fixed sum of quality related bonuses, cf. e.g. Bogetoft(1994). Of course, the requirement that manipulations does not pay restricts the usefulness of such information somewhat. On the other hand the measurement costs may also be very small.

Collective or individual qualities

From a regulatory point of view, a crucial question is if it is possible and / or desirable to have different quality levels across customers and distribution companies. This leads to the distinction between:

- Collective regimes
- Individual regimes

In the *collective regime*, all customers enjoy the same quality level – or at lest the same minimal level. The regulator works as a proxy customer and he imposes universal service obligations with respect to quality dimensions as well.

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 customer groups.

Whether to regulate a given quality dimension in an individual or a collective scheme depends on *technical aspects, economic implications* as well *regulatory preferences*.

Quality differentiation in a given geographical neighborhood or customer segment may be technically impossible or prohibitively costly. One reason for this may be the *network property* of electricity distribution. The reliability dimension provides an obvious example.

In other dimensions, it may be possible at small cost to differentiate quality. Commercial quality by and large belongs to this group. Voltage quality lies somewhere between. It is possible to provide neighbors with varying voltage quality through the installation of local filters etc. but it may not be attractive and it does lead to some synergy and motivation problems.

Based on fairness criteria etc, the regulator may prefer the universal provision of quality even though it may be possible to provide different quality levels to neighbors. W shall discuss some fairness definitions below.

From the point of designing quality regulation, an important first step is to choose which aspects of quality should be governed by a collective or an individual regime. To do so in a systematical way, it may be useful to establish even a rough evaluation of the cost of differentiated quality and the preferences for such differentiation. While the former depends on primarily technical aspects the latter depends on both the possible differences in the consumers demand functions and the general preferences of the regulator. Table 2-5 below illustrates parts of such an evaluation.

Table 2-5 Evaluation of quality dimensions wrt cost, value and mode

Quality dimension	Cost of individual regime	Value of individual regime	Choice of regime
Reliability	*Prohibitively high*	*Some*	*Collective*
….			
….			
Response time	*Limited*	*Some*	*Individual*

Note also that even with differentiated qualities that could be settled via bilateral negotiations, it may still be relevant for the regulator to interfere to ensure that a distributor does not exploit its monopoly power to supply too little quality at too high costs (much the same way it may exploit is monopoly on quantity).

Figure 2-7 below illustrates an instance where there are significant differences in the demand for quality from different consumer groups and where it may therefore be worthwhile to introduce such variations depending of course on the costs.

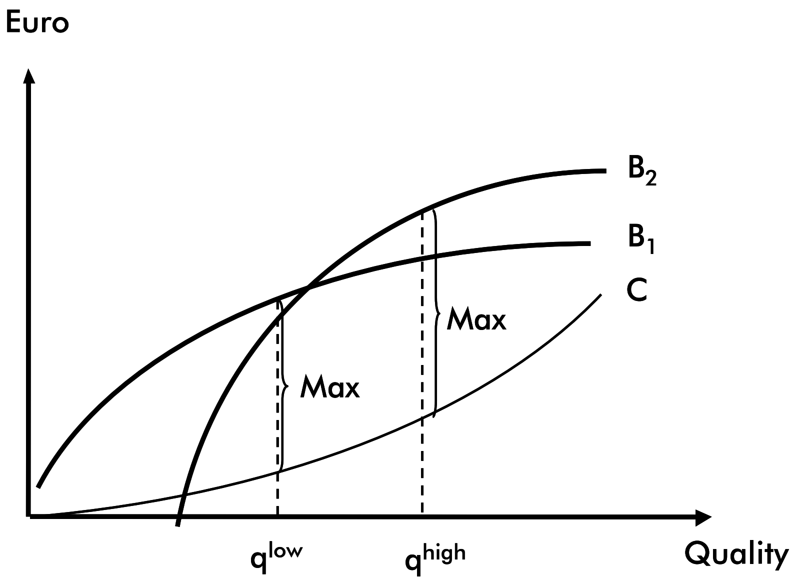

Figure 2-7 Different quality to different consumers

All of what has been said above can – with obvious modifications – be repeated in an inquiry as to the desirability of allowing differentiated quality levels from different distributors. An instance suggesting high social benefits of differentiation provided the regulator does not have a strong desire for fairness or equality at all costs, is illustrated in Figure 2-8 below.

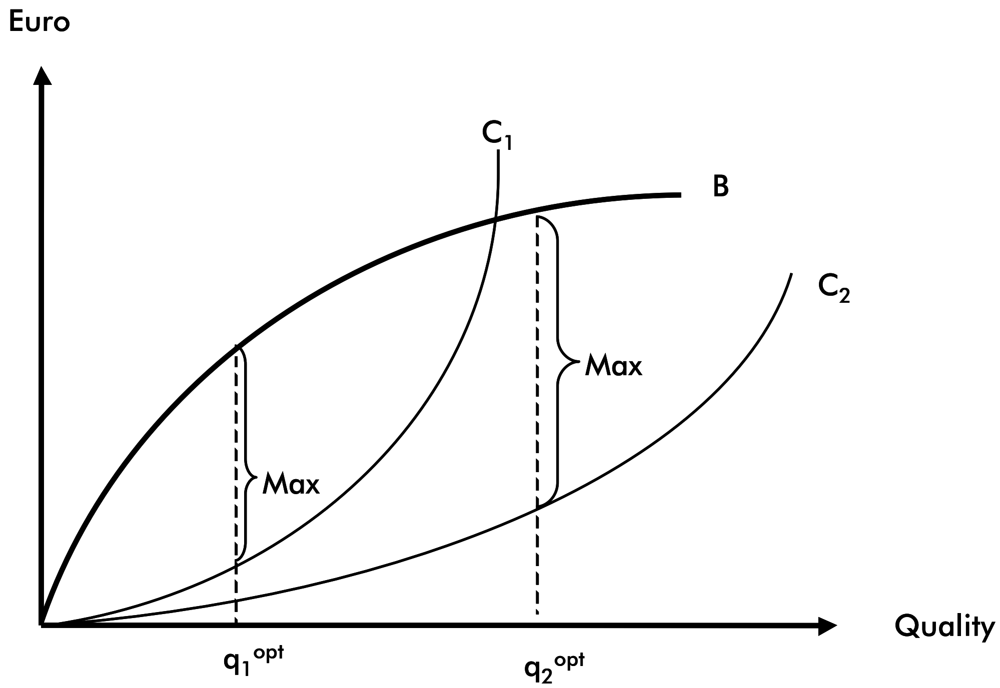

Figure 2-8 Different qualities at different firms

Equality Concepts

A common objective among stakeholders seems to be that different consumers should be treated equally and fairly. This is also related to the universal service obligations. Unfortunately, it is not clear what fairness means.

To illustrate the problems, we note that an equal treatment of different consumers may mean at least three different things:

- All are given the same services for the same price
- All have the same possibilities to choose among different service-price combinations
- All get the same improvements

To understand the differences a restaurant analogy may be helpful. The first interpretation corresponds to the restaurant quests being served the same meal and paying the same price. The second fairness notion refers to a situation where all costumers are handed the same menu. The third situation could refer to a situation with income differentiated prices and products.

Of course, the issue of quality and fairness is part of the broader set of issues related to the fairness of tariff structures. In the Nordic countries, the DSOs have traditionally had considerable freedom in the choice of the tariff structures and hereby in the allocation of total costs on different consumer group. The regulations may have some general guidelines, e.g. that tariffs should be "costs reflective", but exactly what this means and how it shall be implemented is seldom made precise. Moreover, theoretically, it can mean many different things with different implications on the incentives in the system, cf. Bogetoft and Olesen(2005).

It is beyond the scope of this report to define exactly what fairness means. We do suggest however that an important question in the design of a regulatory scheme, including the regulation of quality and the tariff structure, is to analyze and agree on some more precise notions of fairness.

Bundled or Separated Regulation

Another important general question in the design of a regulatory framework for quality is the extent to which the regulator should implement different dimensions jointly as a package deal or separately as a series of individual regulation problems. Given the information problem and the likely strategic behavior of firms and consumes, the joint implementation has advantages. By bundling the dimensions, the parties can be induced more easily to reveal the underlying costs and benefits, cf. e.g. Antle, Bogetoft and Stark(1999).

Comprehensive or Partial Regulation

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 benchmark 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 be 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 possible interaction of quality and quantity and the possible gains from bundling quality and quantity signals.

Implementation

Given a reasonable amount of information about costs and benefits, the (near) optimal quality level can be determined. The natural next question is how the regulator can steer the firms (or consumers) to choose these levels. There are several such ways and in this chapter we outline some important ones and discuss their pros and cons in the context of uncertainty and asymmetric information. The methods can be used in an individual as well as in a collective scheme. We emphasize the steering of the firms but we note also, as we shall return to, that similar steering of the customers is possible via demand management schemes.

3.2 Steering mechanisms

We shall now outline four principal ways in which the DSO may be incentivized to adjust quality towards the socially optimal level, the q^{opt} in Figure 2-6.

One possibility is to use a *generalized price plan* where the firm is reimbursed an amount R(q) equal to the consumers benefit B(q) minus a lump sum (quality independent) payment A:

$$R(q) = -A + B(q)$$

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 consumers and low values means that the gains go the firm. This scheme is illustrated in Figure 2-9 below.

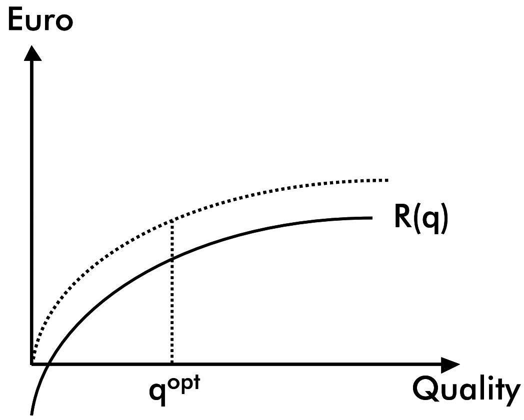

Figure 2-9 Generalized price plan

The generalized scheme is advantageous by leading to optimal quality levels for all possible cost functions. The regulator do not need to know and constantly track changes in the costs function except to determine the exact range in which A can be chosen. On the other hand, the regulator needs considerable information about the benefit function. To collect such information, the regulator may undertake willingness to pay and consumer choice studies where a number of consumers are asked how much they are willing to pay for improved quality and how they would choose in some hypothetical choice experiments. There is a considerable literature on the design of such studies and a large body of practical experience, in part from the marketing science. Still, the collection of information about B(.) may be a non-trivial task. Moreover, it may be difficult to communicate especially in the multiple dimensional case.

A second possibility is to use a so-called *two-price scheme* where the firm is paying a lump sum amount A for the right to make quality decisions plus a relative high price for quality improvements, when quality is low, and a small price for quality improvements when quality is higher:

$$R(q) = -A + p_1 q - p_2 \max\{q - q^{opt}, 0\}$$

This scheme is illustrated in Figure 2-10 below.

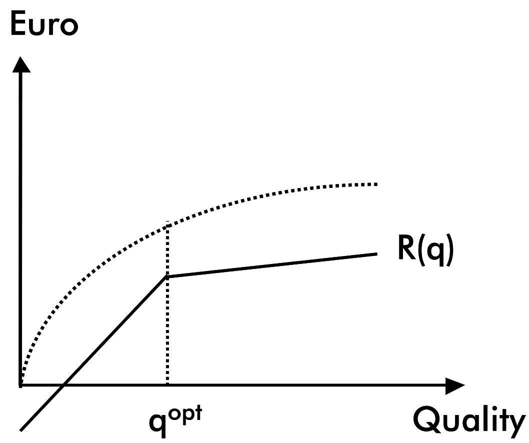

Figure 2-10 Two-price plan

The advantage of this scheme is its relative simplicity making it easy to communicate and to adapt to. Also, the outcome is less sensitive to changes in costs and benefits than the restriction based approach.

A third possibility 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 improvements equal to the marginal value to the consumers in optimum:

$$R(q) = A + pq$$

This scheme is illustrated in Figure 2-11 below.

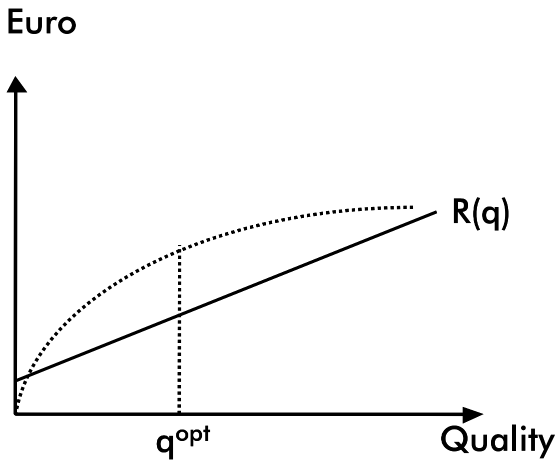

Figure 2-11 Marginal price scheme

The advantage of this scheme is its relative simplicity making it easy to communicate and to adapt to. Also, the outcome is not too sensitive to changes in costs and benefits. On the other hand, the estimation of marginal value in optimum must be rather precise.

The final possibility we will consider here is to use a *restriction based plan* similar to the familiar minimal quality 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 mean that all the gains from adoption to optimal quality go to the firm and low values that the gains go the consumers. This scheme is illustrated in Figure 2-12 below.

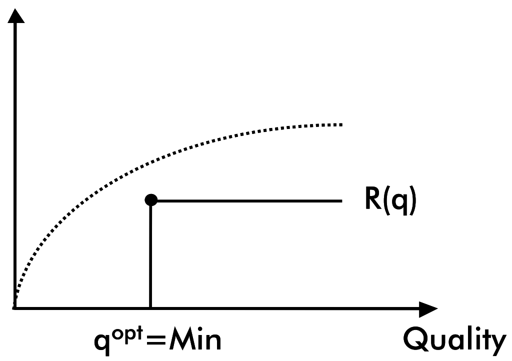

Figure 2-12 Restriction based scheme

The advantage of this scheme is its simplicity making it easy to communicate 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}.

All the schemes sketched above involved some *lump sum* payment, denoted A. The size of this payment depends both on the way the non-quality revenue model is calibrated and on the way the gains from quality adjustments shall be distributed between DSOs and consumers. By and large, however, the incentive effects are not dependent on A and we shall therefore leave the problem of setting A for future more detailed studies. To illustrate the idea here, it suffices to note that if, for example, we assume that the reimbursement for the non-quality dimensions presumes a given minimal quality level, the quality payment schemes shall ideally be interpreted as penalty or bonuses for deviations from these minimum levels. This means that A shall be chosen such that the quality payments are 0 at the minimal levels.

Robustness to changes in costs and benefits

All the schemes above require information about benefits and –except for the generalized payment plan – costs. Since such information is noisy at best, it is important in the choice of regime to consider the impact of having mis-specified costs and benefits – or to have changes in costs and benefits over time. We have already indicated that he generalized scheme is the most robust to changes in cost structure and the restriction based among the least robust schemes in this respect. Two general economic results may shed further light over this question.

The first, sometimes known as the *envelope theorem*, suggests that 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).

The second set of results concern the relative merits of the marginal price and the restriction based methods. Varying the benefit function has the same impact in all regimes since the signal send to the firm and therefore its behavior is fixed. Quality adaptations to changes in the cost function, however, are severely affected by the regime. In the generalized regime, optimal adaptation is obtained – at least as long as the lump-sum payment is set to 0. The two price system works reasonably as well, although of course not as well as the generalized scheme. To choose among the price and restriction based approaches, we need to consider the elasticity of supply and demand. When the demand is rather elastic, i.e. the marginal benefit curve is relatively flat compared to the supply curve, i.e. marginal cost curve, price regulation leads to the smallest losses. This is intuitively natural since in this case it is of particular importance to take into account the costs. Figure 2-13 illustrates this.

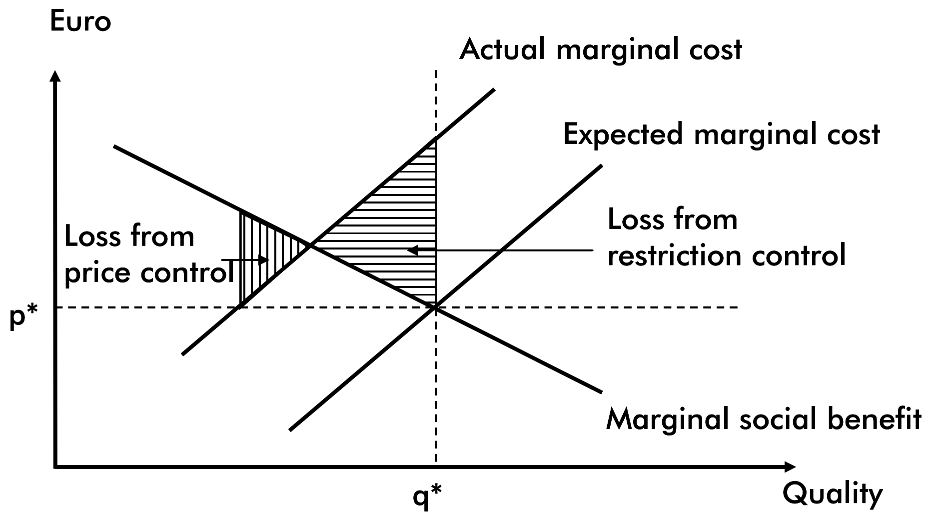

Figure 2-13 High elasticity of demand.

Similarly, when the demand is rather in-elastic, i.e. the marginal benefit curve is relatively steep compared to the supply curve, the adaptation to costs should play a smaller role and therefore minimal standards are superior. Figure 2-14 below illustrates this case.

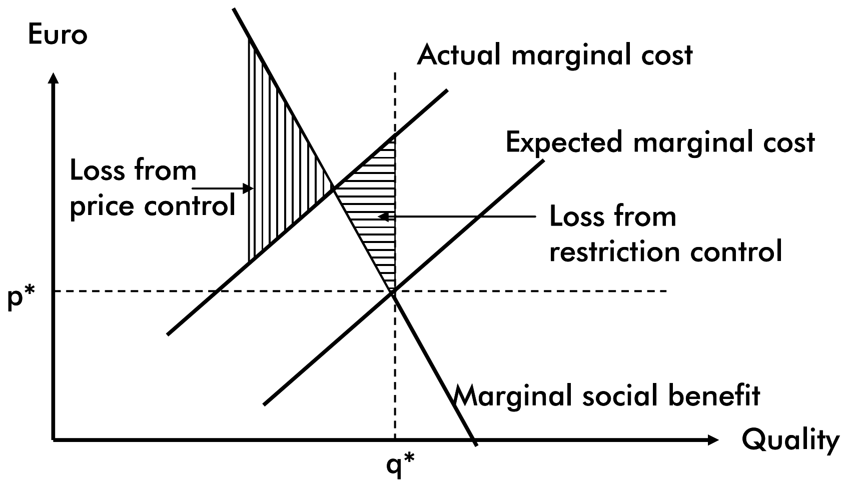

Figure 2-14 Low elasticity of demand control

Decision rights to the best informed

Traditionally, quality decisions are delegated to the firms and indeed this is the perspective we have used in the discussion of implementation above. 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. For other quality attributes however it is possible to let the consumers decide, either through consumers associations or on an individual basis. This could be the case for example for voltage quality or more obviously, for some of the individualized business qualities. The four implementation mechanism above can conceptually be turned around to cover consumer based implementation. In such cases, the regulator should set up payment schemes or price plans stating what the consumers should pay for different level of required quality. Even the restriction based method can be used in this case. It would be a maximal allowed quality requirement below which the consumers can choose.

A key question in the allocation of decision rights 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.

3.3 Conclusions

We have shown above that quality can be regulated in a number of ways.

In theory, it would be ideal to integrate the quality and quantity regulation into a comprehensive regulation. In practice, however, we suggest that a separated add-on quality regulation may be better. It puts quality high on the agenda which conforms to the stakeholder interests in the Nordic countries. It sends a clear signal to think about quality and to make the necessary long terms investments. DSOs will have incentives to think of quality even if they are cost inefficient with respect to the quantity dimensions.

One can also argue that an ex post yardstick regime in theory is superior to an ex ante regime. We shall return to this in the discussion of quantity regulation below. When it comes to quality, however, we do not believe that an ex post regime carries particular advantages. The reason is that quality performance can only be evaluated in a longer time perspective because of the stochastic nature of interruptions etc. This means that the gains from ex post evaluations may be offset by the increased uncertainty. We would therefore suggest that an ex ante regime is quite natural when it comes to the quality aspect.

Lastly, considering the specific choice of payment scheme, we have sketched fours possible schemes above, viz. the generalized price plan, the two-price plan, the marginal price plan and the restriction based plan. In a world of perfect information, it really does not matter which of the approaches one chose. In a world of uncertainty and asymmetric information about production costs, however, the simple marginal cost scheme seems to have particular attractive properties. The incentives are not too dependent on precise and reliable information about both costs and benefits. Moreover, it leaves the adjustments to the DSO who presumably has superior information about the costs of quality. Lastly it is simple and easy to communicate.

4. Asset valuation and capital costs

As electricity distribution is infrastructure and capital intensive industry, the regulation model has to take into account the capital costs. Capital costs include first of all the interest paid for equity and debt. This is dependent on the amount of assets and the cost of capital. Secondly, capital costs include the costs from decrease of the value of assets. In the accounting context this is related to investments and depreciation. This chapter discusses the possible approaches that can be used to analyze capital costs.

In practice, the calculated (reasonable) capital costs can be compared directly to (adjusted) profits like in the rate-of-return regulation, or used as a part in revenue cap, or other revenue based regulations. Capital costs could also be used as an input in efficiency evaluation, e.g. a DEA model. Despite the differences in the approaches, the underlying means of defining the capital costs are rather similar.

For practical purposes, it is natural to separate the discussion on asset base, investments and depreciation from issues related to the rate of return. This means separating volume and unit price. There are many possible ways to define both of these components. The following sub-sections will first discuss the questions related to defining the asset base, and then discuss separately the issue of rate of return.

4.1 Asset valuation, investments and depreciation

Accounting principles are based on the idea that both sides of the balance sheet show equal amounts of capital, and the both sides lead to the same expected return. In theory the asset base could be calculated from either side of the balance sheet.

Investors tend to look at their actual investment when they assess the return. Shares and often also dept are traded on a market place where the value of the shares or other instruments changes constantly. This means that although equity and debt, the shareholders' equity and liabilities side of the balance, are related to the investors interests, the balance sheet values of these components are not directly linked to the market value and expected return. Hence it is rather difficult to analyze the reasonable return directly from the investor perspective. Furthermore, there may be interest-free debts, like connection charges.

In practice, a natural goal in the regulatory context is to measure the amount of capital tied to electricity distribution activities and hence the natural starting point for valuation is the assets side. This means analyzing the situation from the company's point of view. However, we cannot exclude the equity and liabilities side completely, as this is linked to the reasonable rate of return and will be discussed in the sections below.

The mechanisms that affect the asset base are investments and depreciation. As investments have a long term impact on operations, these are activated in the balance, and depreciated during their lifetime. Hence in the accounting context, investment costs that are activated increase the asset base and depreciations decrease it.

The following sub-sections discuss three different approaches that can be used in asset valuation.

Book value

One natural way to define the value of the assets is to use the values on the balance sheet. These values reflect the historical investments made in these assets, and the value is corrected with depreciation so that the value, at least in theory, reflects the expected lifetime of the assets. Furthermore, new investments increase the total value of the assets. In addition to the asset base, decisions on depreciation are reflected in the profits of the company.

The actual way the assets are valued on the balance sheet depends on the legislation and accounting principles used. In practice, there is significant flexibility in the ways depreciations are defined and to what extent investment costs are activated on the balance sheet. Tax legislation is also a key driver behind the decisions, as corporate tax is linked to the profit of the company.

The first source of variation is the flexibility in depreciation. Typically there are no clear and strict principles how the depreciations of certain specific assets should be defined. Higher depreciations will decrease the profit of the company in the short run, but at the same time decrease the value of the assets. On the balance sheet this means that fixed assets are converted to other types, or paid as dividends to the owners. In the long run, the decisions made on the depreciation policy will have a very significant impact on the asset base.

In practice linear depreciation is the simplest approach for defining the depreciation. This is based on the assumption that the functionality of the component is equal during the whole life time of the component, and equal cost (depreciation) should be allocated for each year. E.g. calculating depreciation by using annuity requires information on the capital cost. In this case the idea is that the total capital cost (depreciation + return on investment) is equal every year during the whole life time. The third well known approach is to depreciate a fixed percentage of the remaining value (and a lump sum in the end). These approaches lead very different development paths during the life time of the components.

There is also flexibility in the treatment of investment costs. There may be differences in how outsourced and in-house installation work and planning are treated. The first is typically treated as a part of investment cost, and activated on the balance sheet, while the latter can be interpreted as a fixed or operational cost item that is included in the income statement. Also service and repair costs may increase the value or extend the lifetime of the assets, but typically have no impact on the book value.

From the regulation point of view the above flexibilities cause severe problems, as the figures of different companies are not comparable. These issues are to large extent also outside the control of the regulators of electricity distribution. The regulator may of course take different positions related to the differences, e.g. see these as strategic choices made by the companies and interpret that the figures describe the actual amount of capital that the company has to pay for. The other possibility is to try to adjust the figures. The first approach is problematic as the historical choices related to activation and depreciation have been made in a different environment, and have not taken into account regulation. The latter position prevents the use of book values in practice, as the regulation is typically not in a position where they can give instruction on the accounting principles used by the companies in their balance sheets.

There are no studies on the actual differences in activation and depreciation patterns, which we are aware of. However, the general pattern seems to be that the book values are lower than those based on so-called technical value, cf. below. Furthermore, the nature of the company (public, private, municipal, cooperative etc.) and the ownership structure may affect the choices made related to activation, depreciation time and pattern etc. One important factor behind the book values is also the fact that age distribution of the network may be skewed due to major electrification projects and construction of new houses and industry.

Replacement value / new value

The possible second starting point in the asset valuation is the actual inventory of network and other assets.[1] This will reflect the actual current value of the network. In the case of replacement value, the idea is to describe the value of a corresponding new network.

Defining replacement value is based on the idea that it is possible to identify the components in the network, and define a (unit) price for each component. To reflect the true replacement value, the prices have to include both the price of the actual component and the construction and installation costs. The valuation can be done on various levels of detail. For example the environment, i.e. geographic, geological, topological etc. questions, have a very significant influence especially on the construction costs. Urban conditions increase also the construction costs. Furthermore the costs are likely to vary from country to country, due to different labor costs etc.

If we consider the value of the assets in the context of regulation, the value should reflect the amount of capital tied in the business, or eventually the capital costs caused by the assets. In practice, these are dependent on the (expected) life time of the assets or the output or income that can be generated by using them. If the value of the components decreases significantly in time, the replacement value does not give an appropriate valuation of the capital.

Due to the reasons discussed above, replacement values do not give an ideal measure of the actual capital costs caused by the network as it is not the right indicator for the current value of the network. In extreme cases, calculating return on the replacement value may lead to allowing return on equity or debt that have been paid back and invested elsewhere.

On the other hand, calculating depreciation based on replacement values may be a suitable approach. Replacement value is correct indicator or basis for calculating the depreciation, if we assume linear depreciation (and no changes in the relative prices of the components). Linear depreciation is based on the idea that that the investment or the replacement value is divided by the lifetime of the component, and this is equal to the depreciation each year.

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[1] The replacement value could also be based on the idea of constructing a completely new network with the same capacity and functionality. This would require a significant planning effort, and will not be discussed further in this chapter. However the Swedish Network Assessment Model (Nätnyttö) is used in this spirit, although on a rather general level, cf. Chapter 2.

Technical value (New value corrected for age)

Technical value is typically based on the same starting point as the replacement value. This means identifying the components and their (unit) prices. However, unlike the replacement value, technical value takes into account the age of the components, i.e. depreciation. Hence technical value aims at reflecting the fair value of the networks assets. Philosophically, the technical value could also be interpreted as adjusted book value, as it reflects the investment costs that are depreciated.

Defining technical value requires more information than defining replacement value. As in the case of replacement value, information on the (unit) prices is needed. However, information on the lifetime and the (average) age of the network or the decrease of value in time is also needed. In the case of technical value, also actual investment cost can be used instead of the standard replacement cost of the components. This means adjusting the depreciation pattern used in accounting so that it reflects the technical life time of the components.

Due to practical reason, the way of defining the technical value in regulation has to be kept rather simple. However, the model should allow some flexibility in the depreciation times, as these vary in practice due to changes in the network and differences in the conditions and maintenance practices. Furthermore, the investment costs, especially the construction costs, vary and environmental conditions need to be taken into account. Possible approaches here are either real investment cost (possibly based on open bids) or unit prices that take into account the differences.

As in the case of book value, the depreciations can be defined in separate ways. The simplest approach is to adopt the straight line depreciation calculated from the replacement value. Key issue here is that is does not necessarily require exact information on the age of the components, but the yearly depreciation can be calculated from the replacement value.

It has to be noted that the depreciation based on the components in the network and their replacement value, does not take into account the age of the components. If the components are kept longer than the life time, the total depreciation over time may exceed the replacement value. This is on the other hand balanced by the fact that this will decrease the technical value as the age of the network increases. This differs from the accounting principles that are based on the idea that depreciations will end once the value of the component is zero.

Similar questions are related to those components that will not be kept in the network until the end of the life time.

In the regulation context the use of technical value reflects the (major part of the) volume of assets needed in the distribution activities. Hence this is one natural basis for calculating the capital costs. At the same time also the depreciation component of capital costs will be defined consistently. However other assets like buildings and especially financial instruments require somewhat different approach.

Current situation

The countries have adopted very different approaches in the asset valuation question. Table 2-6 summarizes the findings from the country analysis in subproject A and presents a summary of the depreciation policy.

Table 2-6. Summary of the asset base in regulation in the four countries

	Denmark	Finland	Norway	Sweden
Asset base	Technical value from actual components and standard unit prices and age correction. New investments based on actual costs.	Technical value from actual components and unit prices and age correction based in linear depreciation (actual age or assumption of 50 % value). Other than network assets based on book value Connection fees are subtracted.	Book value (actual investment cost (for some companies initially technical value after the market liberalization) + depreciation) Note that the DEA model uses replacement value as an alternative	Replacement value from artificial network and standard unit prices
Depreciation	Linear depreciation, transformer stations 40-50 years, lines and cables 30-50 years.	Linear depreciation, transformers and substations 25-40 years, overhead lines 0.4 kV 25-40 y, 20 kV 30-45 y, cables 35-40 y, metering equipment 15-25 y etc.	Linear depreciation, transformers and grid stations 25 years, lines and cables 30 y., metering equipment 15 y.	Real annuity, transformers, stations, lines, cables 40 years, metering equipment 18 y. Other assets based on accounting practices.

We see that all the countries calculate some kind of replacement or technical value. The Finnish system is the most detailed and comprehensive Also, the depreciation times vary significantly, and this affects the depreciation levels and the asset base.

In Finland, the asset valuation is based on the principle that technical value is calculated from the replacement value by multiplying it by one minus the ratio of the average age of the network and the life time of the network. The average age is calculated at a component group level and compared to the expected life time of that component group. The system leaves some discretion for the company to define the expected lifetime, as indicated in Table 2-6. The age is taken into account by linear depreciations based in the replacement value. For a more detailed description of the system, please see EMV (2004).

The depreciation included in the adjusted profit and loss account is based on corresponding linear depreciation as the technical value of the network. Hence the depreciation is calculated from the replacement value.

4.2 Financial market and regulation

This section discusses the cost of capital. The key aspect in the definition of cost of capital is risk. Reasonable or expected return depends on the level of risk. Although electricity distribution, in general, is considered a low risk industry, different risk levels and types (economical, technical, environmental) are associated with each company.

One of the key aspects here is e.g. the fact that different levels and types of risk are associated with equity and debt investments. The first subsections discuss equity and debt separately, and the third subsection analyses the total cost of capital. This presentation in the sections is to large extent based on the Finnish regulatory system (EMV, 2004) and the corresponding background documents. Finally the current situation in the Nordic countries is discussed in the last subsection.

Cost of equity

This subsection discusses a way to define the level of return on equity. The higher the risk, the higher interest the investors expect. The return and risk related to an equity investment is often analyzed with Capital Asset Pricing (CAP) model.

The CAP model acknowledges two main components of risk (Kallunki 2004):

- Market (systematic) risk – how sensitive the value of the equity is to the changes in the general market. One key aspect in this is the capital structure.
- Business risk - fluctuation of return or profit

The model includes risks that are reflected in the profit of the company. Hence it includes, at least in theory, issues like weather, costs related to technical failures, costs from the realization of environmental risks etc. For the same reasons also the risks related to changes in regulatory framework are indirectly included. As the risk is analyzed from the profit, also indirect costs are taken into account. However, it is difficult to take into account rare event, like major technical failures, big storms and big environmental hazards that may have long term effect on the reputation of the company.

The CAP model can be presented in the following way:

$$C_E = R_f + \beta_E (R_m - R_f)$$

where

C_E = Cost of Equity

R_f = Risk free interest rate

β_E = Beta

R_m = Average market return

$R_f - R_m$ = Market risk premium

This structure defines the cost of equity for the specific company in relation to the average market risk. Low risk companies with beta (β) less than one are associated with lower cost of equity. Beta equal to one refers to average market risk level and beta higher than one to higher than average risk.

As the fluctuation of the return on equity is dependent on the equity to debt ratio and the taxation of debt and equity is different (more discussion below), the beta depends on the capital structure. This is taken in to account by the following formula:

$$\beta_E = \beta_A (1+(1-t)(D/E))$$

where

1) β_E = The equity beta reflecting the capital structure
2) β_A = The asset beta. During the first regulatory period the Energy Market Authority will use asset beta of 0.3.
3) t = The rate of corporation tax during the period under review.
4) D = Amount of debt
5) E = Amount of equity
6) D/E = The capital structure (gearing).

Beta can be calculated from the market behavior of its shares. This has been the traditional way in the financial market, but is not well suited for electricity distribution, where the amount of available data is limited as most of the companies are not listed on a stock exchange. The selection of the index describing the general market is also non-trivial.

Beta can be calculated also based on key financial indicators. Typical indicators used are equity-to-assets ratio, gearing, and variation of the operating profit. The risk (beta) related to these different risk sources can be summed (with suitable weights) to describe the overall risk.

In addition to the two risk categories mentioned above, we can identify liquidity risk (FIM 2004), which is typically associated with private (non-listed) companies. However, this risk is related to the ownership structure, not the distribution business itself.

As discussed above, the calculation of beta from the historical data does not necessarily include all such risks that realize rarely and are hence not reflected by the historical profits.

Debt

The interest of dept is lower than that of equity, as this interest will be paid regardless of the profit or loss of the company. The interest rate of debt is also depending on the risk of the company, but the effect of the risk is smaller, i.e. the differences in the yield spread are smaller than in the case of equity. However also the cost of dept can be described as risk free rate + premium.

In the regulation context, the premium can be defined either from the actual interest paid for the debt, or calculated from the industry average and financial key figures (as in the CAP model). If the actual interest rate is used, only rates of return that are based on market price should be used. The interest rate paid to e.g. a parent company or owner does not necessarily correspond to market rates.

Average cost of capital

As equity and debt have different expected returns, the total capital costs are dependent on both and the average return is a weighted average of return on equity and debt. The return on equity has to be higher because the interest on debt is paid regardless of the operational profit of the company and hence the return on equity fluctuated more. Furthermore the taxation treats these two in a different manner, as the interest of debt is interpreted as a cost item, the company does not pay corporate tax on these. Hence it is said that the liabilities have a tax shield.

The Weighted Average Cost of Capital (WACC) model takes the issues mentioned above into account, and hence the average cost of capital can be calculated with the following model:

$$WACC = C_E (E/(D+E)) + C_D (D/(D+E)) (1-t)$$

Here C_D is the cost of debt and the rest of the notation is as above.

The CAP and WACC models are, as such, rather neutral and e.g. in Finland there is wide acceptance on the principles. However the actual cost of capital is heavily dependent on the parameters of the models, i.e. the risk premiums and the beta(s).

Current situation

The four Nordic countries have adopted to large extent similar principles in setting the level of the cost of capital. Table 2-7 summarizes the current situation in the four Nordic countries.

Table 2-7. Summary of the rate of return in the four countries

	Denmark	Finland	Norway	Sweden
Rate of return	long bond (30-year credit secured on real property) + 1%	5-year state bond + 1.98% or + 2.14% for equity (70%) and + 0.6% for debt (30%) (4.77% or 5.21% in 2005)	3-year state bond (3-year average) + 2%	6-year real state bond + 1.6 % (after tax) for equity (30%) and 0.6 % for debt (70%). (4.58% in 2003)
Model used risk premium	No specific model (WACC used in the back ground analysis)	CAPM + WACC	No specific model published (CAPM and WACC used by the regulator)	WACC

The Finnish and Swedish regulators have adopted WACC models. At least currently, both apply a fixed gearing for all the companies. However the percentages are different and this affects the results to some extent. During the first regulatory period the Energy Market Authority will apply the same fixed capital structure to all electricity distribution network operators.

The fixation of the capital structure means that the companies with higher gearing (more debt) can earn higher than expected return on equity. On the other hand fixing the ratio makes the model easier and hence supports the selection of optimal debt/asset ratio, as the total allowed profit is independent of the capital structure (assuming that debt/asset ratio does not affect the beta used in the model).

4.3 Conclusions

The key question is how should we calculate the reasonable return, so that it is possible to attract the necessary capital and guarantee reasonable price level? This consists of two major components, the asset base and the cost of capital.

In the case of the first one there are three different approaches. The book value and technical value provide a possible basis for regulation. The problem with the first one is that it reflects historical decisions related to depreciation and activation policies. These have been done to a large extent before the deregulation of the markets. Hence, these historical decisions may have set the companies to unequal position. On the other hand the second possibility requires collection of data on the actual components of the network. Also in this case it is impossible to get rid of all flexibility, but at least the companies can make a (rational) choice.

In the long run updating the asset base is an essential question. This may be based on either actual investment costs or standard unit prices. The use of real investments costs and network units in updating the asset base leads to different incentives. If the first one is based on open bids, it describes the actual costs caused for the company, and the environmental conditions are automatically taken into account. On the other hand, standard prices give an incentive to make the investments as cheap as possible. If the conditions are favorable, the company may get a higher return on investment. On the other hand this may be in conflict with the quality, and may not treat the companies in different environments fairly.

The use of technical values is a relatively simple and transparent approach. If the unit prices (replacement values) are set to reasonable levels, the technical value approach may lead to fair asset bases, and at the same time fair depreciation levels (based on linear depreciation of the replacement value) in the profit and loss account. However, these are not necessarily in line with the general accounting principles.

Even if the basic principles related to the asset base are relatively straightforward, there are many practical questions that need to be solved. One example from Finland is the treatment of transferable and refundable connection charges. Some companies have collected a significant share of their capital by connections charges, and these are classified as interest-free debt. In the Finnish model these are subtracted from the asset base, and hence no return is allowed on these assets.

In case of cost of capital, CAP and WACC models have been widely accepted, and the discussion e.g. in Finland has concentrated on the way of applying them and the parameters of the models. In the Finnish model, the parameters are set based on the expert opinions of financial market experts. The same principles are used in defining the value of other businesses as well. Hence it seems that these are set based on market expectations. However investors and companies have criticized the level in numerous contexts. It is difficult to see, where the disagreement stems from. On a theoretical level, it is easy to say that there are different conceptions of risk, but what are the actual risk components and sources that are valued differently? One possible explanation may be the assessment of technical, environmental and regulatory risks that are not reflected in the historical financial information.

In WACC higher dept decreases the total cost of capital, as an increase in gearing up to e.g. 70/30 debt to equity ratio does not significantly raise the cost of debt, while the increase in the cost of equity is balanced with the decrease in the share of equity. This suggests that a rather moderate return might be sufficient, if the risk related to the distribution business are low. On the other hand, all investors are not interested in the maximum return as the examples from Denmark show. Figure 2-11 illustrates the link between the capital structure and the WACC and cost of equity using the Finnish CAP and WACC models.

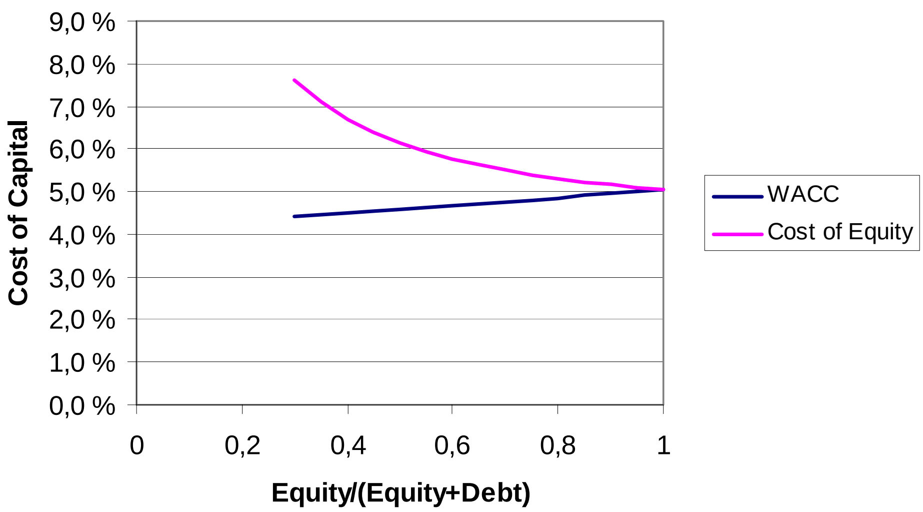


Figure 2-15 Cost of capital as a function of capital structure based on the Finnish CAP and WACC models (Note that in the regulation fixed equity/debt ratio 70/30 is used)

One suggestion has been that old assets and new investments should carry different interest rates. In practice, it may be difficult to separate old and new assets – at least this adds one difficult aspect to the model. Furthermore, from the financial theory point of view there are no grounds for this kind of separation. For the investor who buys the share of a company, all the assets are equally valuable. Hence, it is most natural that the regulation defines the reasonable return on the overall level, and the companies are given full flexibility in their investment and financing strategies.

As a summary we can say that the total level of accepted return reflects the both dimensions of the issue, i.e. cost of capital or rate of return, and the asset base. Both need to be set on a fair level to provide a fair return on equity and debt, and reasonable price levels. It seems that the biggest debate is related to the risks that are associated with the distribution business.

The internationalization of the capital market clearly puts pressure on the harmonization of the regulation models. Otherwise the investments may move to another county in a long run. However, all the owners and investors are not seeking highest possible return.

As the accounting principles in the countries vary, the most natural way to harmonization would seem to be the adoption of technical value based model for the asset valuation and the application of of the same rate of return. As the cost levels vary from country to country, due to differences in geographic conditions etc. the unit prices may be set so that they reflect these differences and the differences between the companies in the same country. Also the possibility to value the investments at the actual cost, seems to be a promising approach, but this would require public open bid process, so that that the construction project cannot be used for cross subsidies.

The use of real investments costs and network units in updating the asset base leads to different incentives. If the first one is based on open bids, it describes the actual costs for the company, and the environmental conditions are automatically taken into account. On the other hand, standard prices give an incentive to make the investments as cheap as possible. If the conditions are favorable, the company may get a higher return on investment. On the other hand this may be in conflict with the quality, and may not treat the companies in different environments fairly.

As indicated above, international financial market creates a pressure for harmonizing the regulatory systems.

The harmonization of the cost of capital calculations seem to be relatively straight forward, and there are no fundamental differences in the ways of defining the level of return. The use of WACC and CAP models is widely accepted in the capital markets and in the energy industry and the current results are also relatively close to each other. There will of course be natural conflicts related to defining the risk level of the DSOs. However e.g. in Finland, the chosen levels are based on studies by independent capital market experts (Kallunki 2005, FIM 2004), and this suggests that the reasonable return in a Nordic model would be close to the current levels. The risk differences caused by different currencies etc. seem to be relatively small, and it is easy to take into account the differences in the corporate tax levels. However, harmonizing the rate of return calculations is not sufficient.

In practice, the harmonization of the asset base calculations is probably more challenging. At the moment there is a great variation in the ways of defining the asset base. The technical value model could be used as a basis as it provides a transparent system but still allows differences in the unit cost and expected life time. As long as the unit costs and life times are defined according to the same principles, the results are comparable and reflect the true differences e.g. in the labor costs or environmental conditions.

5. Yardstick Frontier Competition

In this section, we examine the yardstick mechanism from a theoretical and applied perspective. We emphasize the combination with operational benchmarking methods. In particular, we stress the relationship with DEA models like the ones that have been developed in many countries in recent years.

Yardsticks revisited

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 being compared to the performance of a reference group, and the regulated firm is compensated with the costs of related benchmark firms.

Several articles discuss the use of yardstick competition in regulation mechanisms. However, the practical use of yardstick competition and therefore the empirical literature is rather limited. The literature on contract theory provides analyses of the relative merits of relative performance evaluation (yardstick competition or tournaments) versus fixed performance standards. Holmström (1982) shows how cardinal tournaments can extract information about common risk. Lazear and Rosen (1981) and Green and Stokey (1983) have shown that relative performance evaluation in ordinal tournaments is valuable only when they offer information about common uncertainty. These results underline the importance of selecting a representative benchmark group. Lazear and Rosen (1981) and O'Keeffe et al. (1984) argue that tournaments have an information cost advantage over piece rate contracts. In an ordinal tournament, information about the ranking of the agents is sufficient. Piece rate contracts require absolute information about the agents' performance. It may be cheaper to obtain and report information about the ranking of the agents than absolute information about their performances.

Yardstick competition in electricity regulation

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 the utility's performance compared to the prices, 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.

Resende (2002) discusses the potential and difficulties associated with implementing yardstick competition in the 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.

The use of DEA and yardstick elements has also been investigated in connection with the revision of the Dutch regulation, c.f. Dte(2002).

5.1 DEA based yardstick competition

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. In particular, it solves several of the CPI-X problems discussed in Chapter 2. This includes the risk of setting X too high and hereby risking bankruptcy as well the risk of setting X to low and hereby risking excessive rents. The endogenous determination of the cost norm solves the problem of arbitrariness.

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.

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. We will give a summary of the main findings below. However, to give an overview, it may be useful to summarize the findings already at this point.

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 is lowered. 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 postulated X factor may be substituted by an actually realized productivity improvement. Finally, by using the ex post estimated cost function, changes in production profile can easily be taken into account.

Static Incentives with Adverse Selection

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

- Considerable asymmetric information about the technology
- Risk neutral firms

- Firms seeking to maximizes both profit and organization slack, {Profit + ρ•Slack}

Organizational slack is the cost overrun compared to the minimal possible costs, i.e. slack represents excessive use of resources.

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 costs and the marginal costs are increasing as output expands.

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

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

Optimal Reimbursement B^i *to Firm*^{i}

$= k + C^{DEA}(y^i)$

= *Lump Sum Payment + DEA-Estimated Cost Norm Based on the other firms*

The size of the lump sum payment depends on the firm's alternatives, including its rate of return on capital invested in alternative markets.

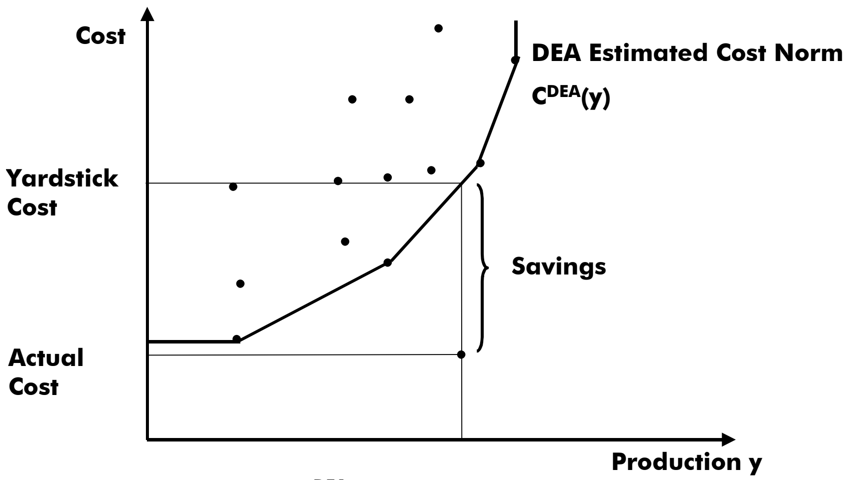
If instead we assume that the actual costs of the firm can be contracted upon, the *optimal reimbursement with verifiable costs* becomes

Optimal Reimbursement B^i *to Firm*^{i}

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

= *Lump Sum Payment + Actual Costs + Fraction* ρ *of DEA-Estimated Cost Savings*

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 2-16 illustrates this reimbursement scheme.



$$R(y, c_0) = k + c_0 + \rho \bullet (C^{DEA}(y) - c_0)$$

Figure 2-16 The DEA yardstick model in the cost – production space

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.

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.

Lump sum and extreme performances

The lump sum payments *k* in the above models may be given different interpretations. In the theoretical analyses it is usually reflecting the firms best alternatives as explained above. It may, however, also be used to increase allowed revenue above the best practice level. This may be useful to ensure the firms against misspecifications in the DEA model – or it may simply reflect that cost reduction incentives and fair competition may be more important that the minimization of DSO rents.

Instead of using an additive lump sum, one may also use a multiplicative risk factor adjustment. In the case of non-verifiable costs, for example, we would then modify the model and reimburse $k^*C^{DEA}(y^i)$. This could correspond to the cost level for say the 80% must efficient firms. Taking such an approach, we could benefit from the flexibility of the DEA models and at the same time protect the firms against the arbitrariness in the extreme performances.

Dynamic Incentives with Ratchet and Limited Catch Up

In Agrell, Bogetoft and Tind (2002, 2005) we extended the above adverse selection and moral hazard context by introducing a time dimension. The dynamic perspective give rise to new issues, including

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

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. Assuming verifiable actual costs, the optimal scheme taking into account the generation of new information, the ratchet effect and the possible technical progress becomes:

Optimal Reimbursement B_t^i *to firm*^{i} *in period* t

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

= *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.

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.

Risk and risk sharing

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.

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 better interference of behavior. The idea is that by looking at the performance of others, we can filter out the general sector shocks 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.

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, cf. e.g. the CPI in the CPI-X model, 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.

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.

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 the case. 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 – 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 that make the behavioral inference less precise. This may make the payments more stable, but it comes at the cost of incentive provision and informational rents.

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.

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).

Limited Catch Up

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

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

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 existing Norwegian mechanism.

5.2 Conclusions

Yardstick competition offers several important advantages in network regulation.

First, the mechanism provides sound investment and efficiency incentives when firms are allowed to retain (part of) the gains. Implicitly, this opens the possibility to share the fruits of efficiency improvements with other clients and other stakeholders.

Second, the regime provides a strong, yet feasible, solution to the information asymmetry problem in network regulation. This means that the implementation, operation and enforcement of model-based yardstick regimes are attainable for regulators even without econometric specialists.

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

In terms of actual implementation of yardstick regimes, however, several issues remain. We shall highlight two here.

The first is shared with other regulations, including the CPI-X regime. The approaches presume that reliable measures of both OpEx and CapEx are available. The latter involves non-trivial asset base and cost of capital evaluations as discussed in Chapter 5. It would clearly be attractive if the yardstick idea could be used on more easily available cost information. We have seen above that if we forgo the verifiability of cost information, the regulation power will have to be relaxed, e.g. using $\rho=1$. This, however, may be a price worthwhile paying to avoid the hassle and arbitrariness in CapEx evaluations.

The second problem is more of a practical problem that relates specifically to the yardstick idea. It concerns the ex post nature of the approach which may conflict with EU regulation and which may lead to practical accounting problems in the firms since they will only learn their income with some delay making it difficult to make the financial statements in due time.

In the BETA regime outlined in Chapter 8, we shall suggest ways to modify the yardstick regime to cope with these problems.

6. Dynamic network concessions

In this chapter, we present a new competitive network auctioning system that provides a workable complement to a DEA yardstick model.

Why do we have concessions?

To assure universal service under obligating quality conditions, distributors are awarded delivery rights and obligations to all connection points in a concession area. To meet these service requirements, the concessionaire must make specific network investments of long duration. To protect the investment, the concession is time limited to 25 years in Sweden, but the duration is at the regulator's discretion (Cf. subproject A). The concession thus plays a double role: it clarifies the responsibilities of the provider towards the customer and it provides incentives for investments. The exact technical definition of the concession is arbitrary and at the regulator's discretion. However, by focusing at the individual customer, the concession is a very important instrument at the regulator's disposal. E.g., new connections, including demand side subsidies and environmental issues may be addressed in an economically explicit manner using concession rights, which maximizes social welfare.

On the feasibility of DEA yardsticks

Subproject C advances a frontier based efficiency model for distribution system operations. In this manner, the model has the double advantage of awarding managerial efficiency on equal footing and to detect possible subsidization of other activities. However, a comprehensive mechanism for long-term use must address the total cost, including the fixed costs that constitute a major part of the overall bill. Immediately after investment, an asset is considered admissible tariff base and will be depreciated according to technical and economical life length. In a pure OpEx-regulation structure, there is no incentive to reduce such long-term investments and the industrial restructuring is primarily driven by market access concerns, and less by cost efficiency. However, even respecting the *ex post* regulatory principle for the operating costs, that may vary according to weather, climate and other non-controllable factors, the distribution network and the capacity may be more controllable on a long-term basis. Also, there are obvious synergies between areas that may dynamically reshape the network to minimize the fixed cost component of the network bill. As the information about these conditions is asymmetric and private, the regulator cannot impose a priori network properties. Without regulation, however, the informational rents would be plausibly extracted by operators selling their firms, and subsequently their de facto license obligations, to other network operators. To remedy these problems, without introducing additional hold-up problems, we shall now *suggest a revised license construction and an auctioning of licenses*.

6.1 New license principles

Two types of delivery licenses may be awarded to network operators in an area; the primary license (P) and the supplementary (S). By default, the current license holder is granted a primary license. The license is limited in time and in space, as decided beforehand by the regulator.

Primary supplier

The primary license comes with *delivery obligation* and *preemptive delivery rights*. The obligations state that P must offer services to any one customer in the area so requesting, if applicable after a reasonable delay. Additional socio-economic requirements, such as the equal access and pricing principle may also be included in the primary delivery obligations. The preemptive delivery rights state that P may connect any customer of choice in the area, provided that this can be done without discontinuing service at any time. All new customers are obliged to address P for new connections, although P may refrain from exercising delivery rights if a supplementary license holder and the customer agree to do so. The primary license is awarded for a full period. Note that P does not need to own, nor independently operate any physical network in the area.

The idea is to charge P with the full responsibility of network operation, in exchange for a limited legal monopoly. The monopoly rights protect his specific investments from hold-up and possible 'cherry'-picking by entrants. The imposed time limit and the succession mechanism to be described below discipline the operator to operate cost-efficiently.

Secondary supplier

The supplementary license (S) is a non-exclusive weak delivery right and obligation to service any customer in the area already connected to the distributor. The supplementary operator may not discontinue service to any customer, unless so requested by either the customer or the primary license holder. The license holder may sell, lease out or outsource any parts and pieces of the physical network to any operator. The multi-agent arrangement enables smooth succession without hold-up problems, limits the effects of potentially sub-optimal concession areas and introduces a natural competition.

Auction

At expiration of the license or at the violation of the license contract, the regulator invites current and prospective network operators to bid for the franchise. The bidders supply bids for the non-regulated fixed charge of service in the area. The franchising contract stipulates that all variable charges, defined as the controllable cost in the DEA-model, cf. Agrell and Bogetoft (2003), will be subject to the *ex post* yardstick competition mentioned above and thus excluded from the bid. The bid constitutes the total annual fixed charge, in real terms, to be allocated across customers in the area. The allocation rules are subject to the rulings of fairness and reasonability in the legislation, and are not assessed in the auction. Threshold limits for quality and other performance measures, as well as penalties for delivery failures, are specified in the franchising contract.

The primary license of the area is awarded to the bidder with the lowest total expected cost, as evaluated by the DEA norm.

Any operator currently operating in the area will be granted supplementary licenses, unless they are disqualified due to inconsistent delivery quality or other violations of the franchise contract. The secondary provider is reimbursed by the primary provider at the previous rate. No fee or compensation is paid to the regulator or the previous primary license holder.

Charges

The customer in the new system pays a single invoice issued by the primary distributor. The invoiced amount contains the following elements:

- Charges for electrical power, billed on behalf of retailer of choice. This charge is competitive and not regulated.
- Charges for transmission on behalf of transmission operator. These charges are subject to specific monopoly regulation.
- Charges for operations, maintenance and metering by the distributor. These charges are regulated by the dynamic DEA yardstick competition that assures minimal costs for every technology.
- Allocated charges for depreciation of fixed capital and cost of capital. These are set by competitive auctions for a limited time and are minimal at the time of the auction.
- Taxes. Energy taxes and value-added taxes.

As in the current system, the local customer bears the full short- and long-term costs of all four tiers in the electricity industry. There are no subsidies paid, neither directly to the operators, nor to the consumers.

The primary distributor cannot discriminate in price or other conditions against customers that are connected to a secondary distributor. Neither can a primary distributor refuse connection by a new client in the area.

Properties of the New System

The dynamic auctioning system offers a number of interesting possibilities that render it viable in a long-run regulation. An old problem in franchise auctions (cf. Williamson, 1976) is that entrants can win licenses by underbidding incumbents and subsequently acquire the assets at a 'fire sale', when the incumbent has lost its delivery rights. The incumbent is to some extent blocked by accounting rules to depreciate assets below equity, and cannot successfully defend itself against such hold-up. The proposed system with tiered delivery rights and the separation of ownership and operation protects the incumbent without limiting an efficient entrant. One may show that the settlement on the true replacement value is an equilibrium solution to the negotiation after an entrant has gained access. The incumbent has no reason to sell below replacement value, knowing that the entrant is obliged to deliver and the cost of bypass. The entrant, on the other hand, is not forced to immediately bypass an unwilling incumbent, since the latter is obligated to continue delivery at fixed terms until released.

> *The new system does not introduce a hold-up problem by the incumbent against the entrant.*

An inefficient incumbent has no private interests to block market entry by efficient operators. Instead, the inefficient operator would prefer to extract lump sum rents by a merger or buy-out, keeping the benefit of inefficiency from the clients. A less informed but efficient entrant may hesitate to bid in an auction if the incumbent credibly could signal that it would not concede *ex post*. The auction mechanism lowers the incentives for such manipulation, giving the entrant preemptive delivery rights. In this manner, the entrant may gradually replace the customers that may be served at minimum cost, rendering worthless any specific investments that the incumbent has made to those clients. The threat not to sell the assets at replacement value is not credible in a repeated negotiation. Hence, the bypass option is only a theoretical construct to prove the bidding parity. In reality, only necessary and efficient investments would be made by the entrant, replacing inadequate or obsolete network components.

The new system decreases the informational rents by the operators.

The network valuation is the primary source of asymmetric information. Without an open auction, the incumbent has incentives to claim that any past investment is necessary and prudently incurred. Without the auction, the entrants have disincentives to reveal any information they may have about the network, since they may share the rent with the incumbent in a buy-out situation. Ample experience has shown that networks with modest operating margins have been sold with considerable premium compared to book value. Without information, the regulator cannot differentiate among true increases in replacement value that justify appreciation of assets, and pure rent extraction through accounting manipulation. An auction is an effective and simple mechanism to elicit information on value. However, without the delivery obligation, the franchise auction would resort to "cherry-picking" of low-cost customers and leave remaining customers to high-cost supplementary operators.

The new system introduces intra-license competition.

The DEA yardstick system introduces competition in operations, the co-existence of multiple operators in the same area introduces the possibility to dynamically shape optimal distribution areas through supplementary licenses and side-agreements. Thus, the *a priori* area definition by the regulator is less crucial for the cost-efficient operations, as distributors may connect neighbor customers gradually, passing side-payments to supplementary operators for covering the delivery obligations. Innovation or technical development may lower cost for certain connections in adjacent areas. Normal market mechanisms now give incentives to such restructuring of the physical network, including grid investments. The operator involved, be primary of supplementary, may freely arrange the ownership and cost allocation for such investments. Under any circumstances, the customer is sure to benefit from a guaranteed fixed connection charge and a competitive variable charge.

The new system limits the regulatory risk compared to complete ex ante regulation.

In *ex ante* regulation with periodic rate reviews, the ratchet effect is considerable for network operators. Combining an auctioning scheme to a complete *ex ante* regulation with a fixed price would place considerable risk on the operators, since this would entail forecasting the detailed costs for administration, maintenance, metering, and operation, as well as the overall design of the network, necessary investments and capacity costs. Although the risk argument speaks in favor of such arrangement, the considerable benefit that the DEA yardstick regime gives to regulate operating cost offsets the limited risk-sharing costs. As discussed below, this is particularly true in situations like the Nordic, with many licenses and probably few bidders. The duration of the license may also be adjusted to achieve a reasonable compromise between industrial and consumer interests.

Investments during the license period

An operator has rational incentives to increase the capital intensity above the original bid, if the discounted reduction of operating cost exceeds the net burden of capital costs and depreciation. Thus, investment signals are the same as in a private enterprise.

Quality provision

As argued in Chapter 3, quality consists of both verifiable and non-verifiable attributes. The regulation of verifiable attributes has been discussed at length, but the risk of deteriorating non-verifiable quality aspects is often present in electricity distribution. The proposed system draws on economic theory (Neeman and Orosel, 1999) to handle such risks in a convenient way.

The key instrument is the tier-breaker property in the auction. We have argued above that the firms have incentives to (i) bid the optimal capital structure and to (ii) settle for the true replacement value. In the case of equally informed firms, a tie would occur at equilibrium. The following allocation rule is now implemented:

> *At tie, incumbent retains license if and only if quality has remained consistently high during the license period, else the entrant is awarded the primary service.*

Since primary service also is associated with other market benefits, such as primary choice of retail and market information, primary providership is strictly preferred to secondary providership for equal efficiency. Thus, the mechanism gives incentives to maintain even non-verifiable but observable quality attributes.

In addition, an operator that fails to deliver a consistent and satisfactory service, as defined by relevant quality regulation may be penalized by immediate auctioning and/or ineligibility as operator in the area. Compensation for non-delivered electric power is regulated by a separate regime.

Competition in bidding

Two likely problems in the implementation of the proposed system are (i) market information by the firms and (ii) limited number of bidders.

Given the current regulatory culture in the Nordic countries, firms may initially demand high premiums to be regulated with the DEA yardstick. This translates to high prices in the auctioning. Such behavior is a rational reaction to changes in the market structure. The remedy is to (i) inform and educate the firms on the DEA yardstick and (ii) a phased implementation. Open information and education can be facilitated by the active involvement of Nordenergi. A two-step introduction of the system would allow the current firms to adjust to the yardstick regulation, which would lower their risk premium in future auctions. The two-stage approach also has the added benefit that stranded cost from the cost-recovery period may be addressed in an acceptable manner.

Given the informational asymmetry, bidders take risks by bidding even on adjacent networks. Since the profitability depends on dynamic operating excellence, rents cannot be guaranteed without good information. The specificity and complexity of the activity also limits the number of potential bidders in any auction. Thus, the competitive feature of the auction may be overstated if only few bidders participate. However, the mere element of auctioning the license has a disciplining effect on firm behavior, even if the license usually is retained by the incumbent.

The risk of collusion among firms deserves explicit mentioning for any regulation regime. Empirical and theoretical evidence shows that hard competitive incentives applied to environments with few, relatively homogenous operators may provoke collusion among agents. The risk is accentuated when industry perceives risk of regulatory opportunism and uncertainty. The DEA yardstick does not depend on the firm's performance and requires all firms to collude to be manipulated. In the Nordic situation, with over 500 firms and considerable diversity in ownership and governance, the risk of collusion in operations is fairly low. However, the informal and strong cultural ties between the few potential buyers might incite collusion in bidding. Once again, the mixed ownership provides currently some protection against this risk.

6.2 Conclusions

In the long-run, competition, innovation and operator succession may be important issues for a viable regulation. We have outlined a modern and robust regulation principle with rolling yardsticks for operating costs and regular franchise auctions for capital structure and technology. The system opens not only for efficient operation by an arbitrary number of operators, or within arbitrary license areas, but incentives for efficient dynamic development of areas, services and technologies. The auction gives a mechanism to counter various hold-up problems by incumbents and entrants. The system is robust in operational competition as it holds the primary providers as accountable for the overall operation, regardless of who performs or owns the actual network. From an industry viewpoint, the system offers leeway for structural, technological and operational development with minimal involvement. Quality, safety and public service objectives are explicitly addressed in the new system through franchise specifications, termination thresholds and the tiebreaker feature.

7. Harmonization

Comparison of the regulation systems

In Subproject A we demonstrated how the current systems are based on somewhat different mechanisms. The regulation systems in each country can be summarized as follows:

- Denmark has abandoned the somewhat complicated revenue cap and rate of return regime, and moved to a temporary price fixation scheme. A new price cap system is under construction.
- Finland has a well-established rate-of-return ex-post approach. Since 2005 it has been refined and complemented with a CPI-X type of cost cap ex-ante component. At the moment the system does not include a company specific X factor, and hence no benchmarking is included.
- Norway has adopted a CPI-X type of revenue cap approach with clear ex-ante emphasis. The system is established and stable. DEA benchmarking (yardstick) is used for defining the company specific X factors.
- Sweden has moved from the light handed ex-post regulation (and de facto price fixation) to use of ex-post technical norm model (NAPM). Concession granting is seen as a long term component in the regulation. These are complemented with DEA based benchmarking, that serves information dissemination purposes.

This illustrates that even though the systems aim at rather similar goals (creating markets in production and sales, and guaranteeing reasonable tariffs), they are philosophically and technically somewhat different.

The main philosophical difference is probably between Sweden relying on a light-handed ex post approach and Norway relying on a somewhat heavy-handed ex ante regulation. Still the difference between the ex ante and ex post perspectives are not always large in practical implementations – and EU regulation is calling for a common approach emphasizing ex ante.

Technically, the main difference is probably between the Swedish Network Performance Assessment Model and the empirical frontier models used in the other countries. Again, however, the complementary DEA model in Sweden has many similarities with the benchmarking model in the other countries, even the Danish that relies on a simple variant, the so-called COLS approach.

The countries are on very different stages in the implementation of the regulation systems. Both Sweden and Denmark have experienced problems with their regulation systems, and this has resulted in changes in the regulation principles. Norway has proceeded relatively consistently with the same approach. The Finnish situation is somewhere between the extreme cases.

We can conclude that the information exchange between the regulators has not lead to natural harmonization of the systems. Hence the harmonization would require a more formal attempt and involvement of the ministries and even political decision makers.

7.1 Alternatives

There are many was that joint pan-Nordic efforts could be introduced and intensified. To structure the alternatives, we can group them from the least to the most radical alternatives using the three overall levels from Subproject A.

The *least radical alternative* would be a continued micro-level collaboration between regulators on the one hand and the industry partners on the other. The collaboration could involve

- improved and harmonized data collection procedures
- a joint data base
- a joint benchmarking model
- common investigations and consultations documents on a case by case basis

An *intermediate option* would be to foresee an intensified process propelled by the Nordic Council, following up the Ackureiry declarations on TSO missions by a similar on DSO tasks, inspiring a "mid-level" political pressure to initiate regulatory reform. This process could already address some principal issues regarding the need for centralized versus decentralized regulation. Collaboration could involve

- choice of some regulatory elements, e.g. ex ante or ex post, centralized or decentralized,
- common compensation principle to handle quality aspects
- plan for long term harmonizations

A *maximal commitment solution* would involve the formal establishment of a common Nordic regulator (NORDREG) in the sense of the Directive, likely along the creation of a single Nordic TSO for the NordPool area.

7.2 Pros and Cons

The harmonization of regulation could lead to

- Improved learning across DSOs, regulators, and other stakeholders
- Better structural adaption by making it easier for DSOs to operate in different countries, by compensating for the small sample bias problem, by avoiding that the regulator reduces mergers etc to keep a sufficiently large number of observations
- Improved long term stability and hereby protection of specific investments by making the commitment at a trans-national level
- Increased competition for DSO role by making it easier for DSO to bid for concessions in different countries
- Increased EU influence by taking the EU initiative in terms of network regulation, energy market design and coordination.
- Completed Nordic coordination via a semi-structured coordination at DSO level
- Improved competition at the suppliers level – e.g. among investment bankers and builders that have to only learn one rather than multiple regulations, i.e. low barriers to entry

- Less trial and error by learning from best practice in regulation and from pooling regulatory resources
- The stakeholder have relatively similar interests and objectives across countries

I further argument for – or at least not against - harmonization is the similarity of interests and objectives across countries, cf. Subproject A.

IEA (2004) in their country analysis of the Swedish energy policy suggests further harmonization of the network regulation e.g. through the Nordic council or similar. The European Regulation Forum on Electricity Reform (SESSA, 2005) also highlights the need and readiness for harmonization in Northern Europe, using e.g. the Norwegian regulation as an example of modern incentive regulation for both efficiency and quality. Finally, the new provisions for regulatory delegation in the Directive and the strong promotion of regulatory bodies as ERGEG by the European Commission clearly signal that harmonization is on the EU agenda.

Cons

The introduction of more harmonization also involves the challenges of having to
- Cope with sunk regulation costs
- Cope with accounting principles that differ and are set at the economy wide national level such that harmonization does not only affect the DSOs
- Cope with the time delay in any harmonization exercise
- Write the new joint regulation into legislation and pre-ambles

Objectives

The objectives identified in stakeholder analyses, cf. Subproject A, include
- Cost efficiency and quality
- Stabile tariffs and stable regulation
- Security of supply

Quality is important – and in particular - security of supply is important. The current regulation models do not put high emphasis on the quality issues, but the results suggest that the importance is rising. This finding is supported also by European work on regulation such as SESSA (2005) and EC (2004b).

7.3 Conclusions

As there is practically unanimous consensus on the need for regulation, the key challenges are related to the implementation and change of 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.

Changing legislation is a long process, but this cannot be seen as a major challenge for the harmonization. The biggest issue is the political commitment. The willingness to commit to big changes may be limited. Furthermore, the mindsets in each of the countries are reflected in the incumbent regulation, and resistance to e.g. introducing more direct market mechanisms may be high.

The analysis also shows that at the moment the driver for change in the Nordic countries is not the EU policy, but rather national interests. In the long term, it is evident that EU favors harmonization, but is not actively enforcing it at the moment. Proactive work might be used in influencing the development at the EU level, which seems to actively welcome this kind of regional initiatives.

In addition to the policy makers, also companies may object to changes in the regulation system. They have invested time learning the current systems and may fear that they – or at least some of them – may be worse off in a new regulation. The DSOs want to see that the new pan-Nordic model offers something better for them. As stability and predictability are clear goals, the creation, or mere discussion, of a pan-Nordic model may be seen as introducing some regulatory uncertainty.

8. Alternatives and evaluations

Synthesis from A

The system analysis in A 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

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. In spite of some political smoke, 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 efficient operation, restructuring and reinvestments.

Output focus

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. Hence, the proposal should be forward-looking and output-focused.

Quality of service

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.

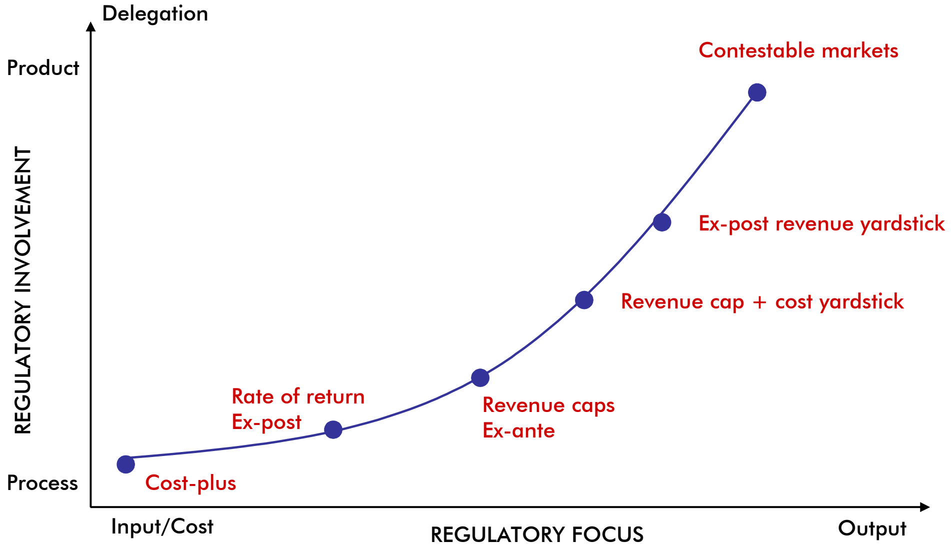


Figure 2-17 Dynamic developments in regulation involvemebt and focus

Three alternatives

The trend is illustrated in Figure 2-17. As discussed above we cannot feasibly go back from the most advanced regulations proposed. However, for continuity, we need to present three alternatives with varying level of achievement towards the three goals. The three alternatives are internally consistent and each adds a particular dimension towards the objectives stated. A single proposal for quality regulation is advanced, followed by a set of regulatory reforms to enable the harmonization.

8.1 ALFA. The Yardstick Competition Model

As argued above, the only viable principle is based on yardstick competition, where the firm has no influence on its cost target and where the "market profits" are determined from best-practice performance. Proposal ALFA assumes a regulatory coordination around a structure of the type

$$R(t) = C(t-1) + \Pi(V_n,t-1) + \rho_n\,(C_n^*(t-1)-V(t-1))$$

where $R(t)$ is the allowed revenue in period t, $C(t\text{-}1)$ is the firm's operating cost at t, $0 < \rho_n < 1$ is the incentive power parameter for country n, $C_n^*(t\text{-}1)$ is the efficient cost from a national model n in period $t\text{-}1$ and $\Pi(V_n,t)$ is a standardized cost of capital, based on replacement values or similar. An efficient firm recovers operating costs, the standard capital cost and a share ρ of the efficiency savings. An inefficient firm is subtracted a penalty $\rho \cdot$ *inefficiency* from its revenue cap.

To point out some of the major advantages of ALFA we note that

- ALFA requires only data coordination (cf C), nor a joint model for Vn.

- ALFA provides a clear principle for regulation across all countries, and it promotes investments and, to some extent, output.
- ALFA is directly compatible with the Directive and all national regulation.
- ALFA gives each country the possibility to vary the incentive power (the carrot) and the model (the stick).
- ALFA operates with (national) models to correct for environmental conditions.

Despite of these obvious advantages, ALFA suffers from some important limitations as well since

- ALFA involves only first level harmonization
- ALFA does not address output fully
- ALFA does not necessarily encourager consolidation of firms
- ALFA may open for regulatory competition and higher administrative costs.

We shall return to a more systematic comparison of pros and cons of this regime and the two other alternatives later in this chapter.

8.2 BETA. The Price Frontier Yardstick Model

To (i) create common incentives in the Nordic countries and (ii) to get rid of the input-dependency of the regime and in particular the capital evaluation problem, we to converge on a single model in ALFA and to possibly adjust the incentive power to reflect verfiability problems.

What matters to consumers is price = revenue, not cost as such. Using actual unregulated prices in the yardstick the return on investment is endogenous and not regulated. Tariff levels are set by all firms and regulated ex post depending on the "value for money" set by the other firms. In this way, firms may budget for reinvestments prior to investment, rather than getting caught up in the jerky and artificial problem of network age.

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).

Third, the yardstick model C^* is harmonized, as opposed to the situation in the national ALFA model.

BETA has the shape

$$R(t) = C(t-1) + \rho(C^*(t-1)-C(t-1))$$

where $R(t)$ is the allowed revenue in period t, $C(t-1)$ is the firm's total revenue cost at $t-1$, ρ is the incentive power, and $C^*(t-1)$ is the efficient revenue from the joint model in period $t-1$. The yardstick cost is calculated as the *efficient revenue* at the level of operation of the individual firm. 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, nondistribution tasks and taxes. The joint model takes into account environmental factors to correct for delivery complexity.

The incentive power will have to be adjusted compared to the ALFA regime to reflect that increases in price leads to a profit increase in a given period. Above yardstick charges shall therefore be penalized with more that the price overrun (including interests).

The BETA regime has several advantages, including

- BETA is competitive, modern and fully output-based.
- BETA is robust to any technical developments
- BETA avoids the problem of intra-Nordic regulatory competition.
- BETA makes the capital valuation problem irrelevant.
- BETA is simple to defend and visualize to other stakeholders.
- BETA 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.
- BETA gives potentially high incentives for restructuring, likely to be capped in a transient situation.

We shall return to a more detailed evaluation of the pros and cons of BETA below.

8.3 GAMMA. The Dynamic Network Auction Model

The strength of ALFA and BETA, the yardstick model, is also its weakness in the long run when the market consolidates. The annual revisions become ineffective if only very few firms compete on the market. In fact, the uncertainty shifts to the clients, risking to pay all cost shocks and the rents of market power. To address this situation, one may augment the yardstick model with a fixed element, which also solves possible imperfections in the environmental correction.

GAMMA, developed in detail in Chapter 3, is based on BETA, i.e. a revenue yardstick regime. However, the revenue is now split in two parts: fixed and variable tariffs. The fixed charge for all clients in a concession area is determined through a periodic tender that creates stability ex ante for firms and clients for the investments. However, as operating costs depend on network utilization, exogenous costs and climate, the variable tariff is operated as before, based on an ex ante estimate by the firm and an ex post competitive correction by the yardstick regime.

Some of the obvious advantages of GAMMA are

- GAMMA offers an even higher irrelevance of the capital component.
- GAMMA makes the concession area limits arbitrary to operational efficiency. The DSOs can freely organize the operations to achieve minimal cost.
- GAMMA makes explicit the ex ante investment compensation for a regulatory period, without forcing the firm to take unnecessary risk on the operating cost.
- GAMMA opens the possibility to settle differences in expected cost (positive or negative) on the OPEX part in the ex ante CAPEX settlement. In this way, firms may

pay a positive price if the environmental correction is too generous and demand a higher premium for the opposite case.

We shall return to a more systematic evaluation of GAMMA below.

8.4 QUICK. Quality regulation

As discussed above and in Chapter 3, 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. Supported by the theory and the scientific consensus of SESSA (2005), we conclude that restriction-based regulation is likely infeasible in the long run for the electricity distribution. Rather, a marginal price regime should be favored.

The large number of measurable dimensions (cf. Subproject C) should not discourage the inclusion of quality in regulation, since many of them are subordinate or correlated to reliability of supply.

Thus, we argue for a simple two-price system (cf. 0) or sliding scale with ex ante fixed prices for a long period. QUICK is basically a KILE-like regime for all countries, defined on Energy Not Supplied (ENS) and interruption frequency, supplemented with restrictions for other quality dimensions and a floor, below which the operating license should be questioned. Base level quality should be set by an independent technical and economic review balancing the costs and benefits of ENS and interruptions. QUICK costs for ENS and interruptions are nationally defined ex ante for a long period. QUICK payments (up and down) should be in a large window to provide clear signals.

New entrants (in GAMMA) must provide equity or bonds to offset the risk in QUICK. This is to avoid hit-and-run by newly formed operators that would neglect maintenance only to withdraw in the case of large interruptions.

Compensations from QUICK should be at least partially paid directly to concerned clients, while some of the premium to the DSO from above base quality could be treated as deposits to the balance accounts and hereby be split across the tariff payers

8.5 Regulatory enablers

In this section, we treat some important requirements for the implementation process of any pan-Nordic model.

Common core task definitions

Any coordinated regulation system requires a clear definition of the least common subset of DSO tasks, the *core DSO task* (cf. report C). 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. However, it comes with the added benefit of being able to cost (or even perform) non-core tasks outside of the pan-Nordic regulation, e.g. tasks related to safety inspections, line dismantling and energy planning.

In regimes BETA and GAMMA, all compensation for non-core tasks should be transparent (and preferably based on tendering) to avoid cross-subsidies to incumbents.

The balance account

No jerky tariff revisions are necessary. If $R(t) < C(t)$ for a year, then the difference $C(t) - R(t)$ is recorded as a liability towards the tariff payers in the balance sheet. An efficient firm may analogously book the positive $R(t) - C(t)$ for $R(t) > C(t)$ among the (tax postponed) receivables in the balance sheet. The balance position from the yardstick should be recognized as a reserve/liability when buying and selling firms, increasing the value of efficient firms without obligating them to immediately cash out on the efficiency premium from the current ratepayers. The yardstick principle is simple, transparent and optimal.

Common information system

A common meter standard, including formatting and transmission of hourly data, connections and disconnections would facilitate a pan-Nordic approach. Meter standards could be defined by a "third party", e.g. the TSO. This is a typical coordination task that normally does not result from independent action by firms in coexisting regulated systems. Common standards impact the administrative costs for market facilitation, restructuring (mergers) and control.

Framework agreement

There needs to be a common regulatory vision statement for 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.

A common regulatory body, NORDREG, could easily administer all three models, but the organization of the regulatory institutions is not crucial to the choice of regime.

Financial conditions

The regulators need to harmonize the financial conditions, even for ALFA, not to create perverse incentives between countries. However, this should be seen in connection with a common information system, leading to equal performance criteria. 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.

8.6 Critical success factors

In Subproject A, we examined the critical success factors of a pan-Nordic regulation model.

Based on careful country analyses we concluded that despite of obvious and markedly differences in the incumbent regulations the general ideas and the energy policy priorities are strongly aligned in the four countries. This suggests that a common regulation – or at least increased coordination of the national regulations – may indeed be possible.

We also discussed the common and conflicting goals based on stakeholder analyses. In general, the stakeholder groups tend to agree across the different countries. Moreover, the different stakeholder types (consumers, DSO, regulators etc) tend to agree on the overall priorities although of course not on the detailed trade-off between for example profits and low tariffs.

Economic issues

Economic issues, together with quality, are the most important group of aspects. Hence, it is important both as a common objective and as a potential natural source of conflict between stakeholders.

Among the 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.

Potential conflicts are related primarily to the *level of tariffs and profits*. The conflict arises from the fundamentally different interests of the stakeholder groups.

Quality

Quality in general and especially *security of supply* is an important dimension in regulation for everybody. Thus it is, per se, not a source of conflict. However, there is a clear link between the quality and the economic aspect. Consequently, the conflict in the quality issues would most likely be reflected in the economic issues.

Although *customer service* has been emphasized in several cases it was seen less important issue than security of supply or technical quality by all the groups.

The stakeholder interviews also 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.

Equity, fairness and social and environmental issues

Access to networks and markets is acknowledged as the most important principle.

Other equity and fairness aspects are also important characteristics of a regulation system, if not as goals than at least as side constraints. There is general agreement that regulation should be fair, but there is potential conflict on what fairness means in practice.

Furthermore, although many of the *social and environmental issues* – low environmental effects, compatibility with land-use planning, etc. - are indeed important, 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.

Implementation

As there is practically unanimous consensus on the need for regulation, and since there is quite similar priorities regarding the aspects of regulation to focus on, the key challenges are related to the implementation and change of implemented system(s).

The most challenging issue in the harmonization of the Nordic regulation models is therefore to create a *common commitment* to the process. This would require a situation where all the key stakeholders in all the countries see the process as beneficial (*win-win*).

Changing legislation is a long process, but this cannot be seen as a major challenge for the harmonization. The biggest issue is the *political commitment*. The willingness to commit to big changes may be limited. Furthermore, the mindsets in each of the countries are reflected in the incumbent regulation, and resistance to e.g. introducing pure market mechanisms may be high.

In addition to the policy makers, also *companies may object changes* in the regulation system. They have invested time learning the current systems and not all of them will benefit from being able to use the same understanding and the same business focus in different countries since the majority of DSOs are still only operating locally. The majority of DSOs want to see that the new pan-Nordic model offers something better for them.

Theoretical success factors

All economic systems involve several agents with conflicting interests, private information and private possibilities to act. Specialization however comes at a cost. Information must be shared and actions must be coordinated. In Chapter 2 we discussed how this leads to three overall objectives: *coordination* (ensure that the right services are produced at the right time and place), *motivation* (ensure that the parties have individual incentives to make coordinated decisions) and *transaction costs* (ensure that coordination and motivation are provided at the lowest possible cost).

These three objectives can be concretized and operationalized in ten theoretical success factors (cf. Table 2-2) or rules of thumb as discussed in Chapter 2:

- Coordination
  - Coordinate production
  - Balance the pros and cons of decentralization
  - Minimize the costs of risk and uncertainty
- Motivation
  - Reduce the costs of post-contractual opportunism
  - Reduce the costs of pre-contractual opportunism
  - Do not kill cooperation
  - Motivate long-term concerns
- Transaction costs
  - Balance the pros and cons benefits of renegotiation

- o Reduce direct costs of regulation

Towards a multiple criteria evaluation

One can argue that some of the "criteria" from both the stakeholder analysis and the analysis of economic theory are in fact means rather than ends. Equity in the sense of equal access to the network can for example be seen as an objective in its own right, i.e. a direct source of social welfare. Alternatively, it can be seen as a mean to social prosperity as derived from an understanding of competitive economic systems. In reality, however, this is a somewhat academic discussion. What matters in a practical and political context is more the consensus as to the characteristics of a good regulation – and less the possibly conflicting motivations behind the same operational preferences.

Some of the insights from the stakeholder analysis may be considered as political enablers rather than preferential criteria. Again, however, this is for practical purposes not important since a perfect ideal system that cannot be implemented is a poor system in reality.

Further, one might argue that the criteria derived in Subproject A overlap the criteria derived in Chapter 2 of this report. This is comforting and an indication that theory and practice are mutually validating. Moreover, it allows us to merge the perspectives and hereby to develop a final list of criteria against which to evaluate the alternative regulations. This list involves 14 criteria, namely

- Coordination
  - o Coordinate activities
  - o Ensure low tariffs
  - o Ensure appropriate quality (security of supply)
  - o Balance the pros and cons of decentralization
  - o Minimize the costs of risk and uncertainty
  - o Reduce the costs of post-contractual opportunism

- Motivation
  - o Reduce the costs of pre-contractual opportunism
  - o Do not kill cooperation
  - o Motivate long-term concerns

- Transaction costs
  - o Balance the pros and cons benefits of renegotiation
  - o Reduce direct costs of regulation
  - o Ensure equity and adhere to environmental and safety requirements
  - o Create political consensus and commitment
  - o Use transparent regulation

8.7 Multi-criteria evaluations

We will now evaluate the three different proposals, ALFA, BETA and GAMMA based on the above 14 criteria. The quality regulation QUICK is supposed to supplement each of them and is therefore evaluated as part of these three regimes.

The evaluations are summarized in Table 2-8 below. For each alternative and each performance criteria, we have used an ordinal "star" scale. One star, *, indicates acceptable performance, two stars, **, indicate good performance and three stars, ***, indicate excellent performance.

Below, we will give short motivations for these evaluations, taking the 14 criteria one after the other.

A - Coordinate activities

A very important objective of any economic system is to coordinate the actions of independent decision-makers. Coordination must ensure that the production and investments are optimized throughout the entire production chain. Lack of coordination leads to sub-optimization where decision-makers "optimize" their own decisions without considering all the consequences they have, for other decision makers.

All approaches are doing reasonably well in this dimension. They all give incentives to minimize costs given outputs and assuming that demand is reasonably price inelastic; the output cannot be changed too much. ALFA has the disadvantage that the DSO may be encouraged to affect the allocative efficiency to exploit relative payment differences on capital and OpEx, That is, a DSO under ALFA may potentially gain from choosing a sub-optimal input mix, e.g. excessive capital usage, if this is relatively well-paid. This is not the case in BETA since the different cost types in total costs are included on equal footing here. Also, the DSO will have private incentives to introduce demand management to balance the consumers' benefits against the DSO costs. A potential problem in both systems is however the long term allocative efficiency since it may not be the right DSOs that serve the different concession areas. The GAMMA system where concession areas can be reallocated and reformatted through the auction mechanism have a potential advantage here.

B - Ensure low tariffs

Since all proposals give incentives to reduce costs and since the yardstick competition element give incentives to pass on a fair share of the cost savings to consumers, all systems contribute to low tariffs. Since there are fewer possibilities to gain from changing the cost mix and fewer options to make economic rents on the differences in concession areas as we move from ALFA to BETA to GAMMA, we must expect that the tariffs in the long run are decreasing accordingly.

Table 2-8. Multi-criteria evaluation of alternatives ALFA, BETA, GAMMA

	Criteria	ALFA	BETA	GAMMA
A	Coordinate activities	*	**	***
B	Ensure low tariffs	*	**	***
C	Ensure appropriate quality	***	**	**
D	Balance the pros and cons of decentralization	*	**	***
E	Minimize the costs of risk and uncertainty	***	***	**
F	Reduce the costs of in-period opportunism	**	***	**
G	Reduce the costs of between-period opportunism	***	***	**
H	Do not kill cooperation	**	*	*
I	Motivate long-term concerns	**	**	***
J	Balance the pros and cons benefits of renegotiation	**	**	***
K	Reduce direct costs of regulation	**	**	**
L	Ensure equity and environmental and safety requirements	**	**	**
M	Create political consensus and commitment	**	***	*
N	Use transparent regulation	**	***	**

C - Ensure appropriate quality

In all regimes, quality provision is assured through a separate regulation, QUICK. The ALFA regime may have a comparative advantage by allowing for extra investments (via a high capital payment). The GAMMA regime might have the advantage that the area-specific quality costs are revealed through the periodic auction.

The use of a separate quality add-on is not ideal but has practical advantages and may be a useful starting point. It controls quality via prices as opposed to an input or restriction based approach. In this sense, it resembles the idea of BETA as opposed to ALFA and in particular as opposed to a cost-plus type of regime.

D - Balance the costs and benefits of decentralization

The allocation of decision rights is a key aspect of a regulation. A regulation of distribution may be more or less centralized with more or less decisions undertaken by the regulator. Theory suggests, however, that the parties should aim for decisions made by the most informed party. In this respect, BETA is superior to ALFA since it leaves the optimal CapEx – OpEx allocation entirely up to the DSO. Likewise, GAMMA involves an even more appropriate allocation of decision rights than BETA and ALFA by letting the concession regions be restructured by the DSOs.

E - Minimize the costs of risk and uncertainty

Risk is prevalent in the distribution sector as in most parts of the economy. The companies and consumers are subject to external risk from weather, labor markets, capital markets etc. In addition, the parties are subject to behavioral risk, as they do not know the behavior of the other parties.

We do not have strong evidence suggesting markedly different risk attitudes between DSOs and costumers. Since the distribution charges only play a minor role in family households they are probably close to risk neutral. Industrial consumers may be more depending on electricity prices and hence be less likely to accept risk without a premium. The DSOs attitudes probably also varies from risk neutral when owned by well diversified owners to slight risk averse when cooperatively owned. In Subproject A, many DSOs emphasized the importance of stable tariffs. This confirms that they may be somewhat risk averse. Still, one should be careful interpreting these statements. If the cost level is not stable, stable tariffs may actually lead to fluctuating profits. The preference for stable tariffs may therefore really be a preference for stable regulation and long terms commitment by the regulator.

In terms of risk the main differences between our three alternatives is probably that GAMMA is more uncertain due to the novelty of the approach.

In general, the schemes tend to allocate general risk to the customers. This is probably reasonable given the relative minor importance of the distribution charges in their total costs, cf. above.

F - Reduce the costs of in-period opportunism

In terms of the moral hazard problem, all regimes are doing well due to the basic incentives of a cost independent reimbursement. Moral hazard may however still be of some importance in ALFA since the DSO can choose a sub-optimal OpEx – CapEx structure to partially hide inadequate efficiency effort. It is also a possible problem in GAMMA since the DSO may here try to act strategic in connection with the reallocations of the concession areas. (The latter may also be interpreted as a pre-contractual opportunism problem.)

G - Reduce the costs of between-period opportunism

The between-period adverse selection problem is largely eliminated in the studied regimes. This is a major advantage in comparison with a standard CPI-X revenue-cap regime and is intrinsic to the yardstick approach with frequent ex post up-dating.

The repeated franchise auctions in GAMMA may potentially lead to adverse selection problems. The incumbent will tend to have superior information about delivery conditions and the value of the network which may lead to information rents in the negotiation of a new payment plan or in the transfer of the network to a new winning primary provider.

H - Do not kill cooperation

The parties can only achieve the full economic benefits if they cooperate. The companies can help each other by sharing know-how, exchanging favors etc. Flexibility from both regulator and the companies may enable them to adjust to events not accounted for in the contract. Hence, it pays for the parties to work in a cooperative spirit where changes can be made without costly negotiations or conflict resolution.

The yardstick regimes in general will tend to make the competition fiercer and therefore decrease the interest in sharing good technical and business know-how. In comparison, a CPI-X regime allows the DSO to at least harvest the gains for some years to come before the dissemination of new procedures make the comparative advantages of innovations level out.

In ALFA, the capital compensation could partially shield the DSO and in the GAMMA regime there may be interest in the sharing of information and experience to increase the value of a losing concession holder's network. This suggests that cooperation is slightly less favored by BETA.

I - Motivate long-term concerns

The regulation should induce the parties to consider the long-term effects of their actions. Electricity distribution requires large capital investments that are rather location specific and which has lower value in alternative uses. Such specific investments are particularly sensitive to the ability to make long-term commitments.

A common regulation will tend to increase its predictability, which may encourage investments. The novelty of the GAMMA regime will probably give this regime a strategic disadvantage in the beginning. In reality, however, its logic implies that the network valuation is also coupled with top management and that the initial owner will collect part of the gains from improving management which in turn makes investments less risky. Thus, GAMMA paradoxically both offers the strongest (long-term) and weakest (short-term) investment incentives.

J - Balance pros and cons of renegotiation

All regimes allow the parties to gain from renegotiation. They all adjust to new general information in the industry. This is a primary virtue of the yardstick regime.

The GAMMA regime involves the most formalized and predictable renegotiations. It allows the DSOs to correctly re-evaluated capital and delivery conditions when new auction rounds take place.

K - Reduce the direct costs of regulation

The direct costs of regulation are constituted of the time and money spent on information collection, monitoring, bargaining, and conflict resolution – i.e. the costs of running the regulators. Ideally, they also include the costs of collecting and processing the regulatory information at the DSOs.

All procedures are probably slightly more demanding than a simple CPI-X regime for the regulator since yearly information most be collected and processed. On the other hand, the BETA regime is easier than the ALFA regime since it foregoes the tedious cost measurement problem on the input side. Likewise, the GAMMA regime may put fewer burdens on the regulator than the BETA regime since small specification errors can be corrected in the price setting of the auction.

From the point of view of the DSOs the relative rankings of the three regimes are reversed since the GAMMA regimes requires the DSO to make more profound and informational demanding decisions.

L - Ensure equity and adhere to environmental and safety requirements

In terms of equity and the adherence to environmental and safety requirements, the yardstick structure of all the schemes is advantageous since the cost implications are determined endogenously and do not need to be negotiated or predicted by the regulator. The BETA and GAMMA regimes are particularly useful in this regard since the factors that impact capital evaluations are handled automatically as well. On the other hand, the more heavy involvement of the regulator in the regulation of capital rents in the ALFA regime may also have some advantages since the regulator hereby can reimburse directly and immediately rather than have to wait for the market forces to do so.

Equity in the sense of giving all customers similar prices may also be easier in the ALFA regime. On the other hand, equity in the sense of having a regulation that is neutral to the ownership form, size and the scope of the DSO is best handled by the BETA and GAMMA regimes.

In summary, therefore, the regimes have different impacts on different aspects of this success factor, and taken together there are no strong reasons to prefer one or the other based on this group of objectives.

M - Create political consensus and commitment

From the point of view of creating political consensus and commitment, it seems that the BETA regime has a slight advantage. It represents a principal improvement of all incumbent regimes without taking the regulation into the largely unexplored territory of GAMMA.

N - Use transparent regulation

The regulation should take account of the parties' bounded rationality, i.e. their limited capacity to collect and process information. This criterion – somewhat related to the objective of reducing the direct costs – gives BETA a slight advantage. First of all, BETA is very easy to understand since it mimics a competitive market quite directly. As in a competitive market, success is determined by the prices the costumers must pay for the services. The actual and underlying elements of OpEx and CapEx are irrelevant to consumers in a competitive market.

One could of course argue that the GAMMA regime is also quite simple since entrance and exist are important actions in competitive markets. Moving to GAMMA may nevertheless be a quantum leap for an industry that is used to a cost-recovery mindset.

8.8 Recommendations

We see that none of the alternatives dominate the others. In general, however, the evaluations suggest that BETA is a particularly interesting alternative. It outperforms the other alternatives on many criteria and is only slightly outperformed on a few. Based on a combined desire of proposing a theoretically sound common regulation that in practice can be aimed at on a 5-10 years time horizon, we therefore would recommend BETA for further evaluation.

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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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