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Pan-Nordic Regulation of Distribution System Operations

WHITE PAPER

2005-11-02

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This white paper summarizes the contents of the following project reports from

NEMESYS (2005a) *Subproject A: System Analysis*,
Final report. (Ed.) M. Syrjänen. SUMICSID AB and Nordenergi.

NEMESYS (2005b) *Subproject B: Regulatory Mechanism Design*,
Final report. (Ed.) P. Bogetoft. SUMICSID AB and Nordenergi.

NEMESYS (2005c) *Subproject C: Nordic Efficiency Model*,
Final report. (Ed.) H. Grønli. SUMICSID AB and Nordenergi.

NEMESYS (2005d) *Towards a Pan-Nordic Regulation for Distribution System Operations*,
Final report. (Ed.) P. Agrell. SUMICSID AB and Nordenergi.

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NEMESYS White paper
Report, public, project no 450.
Release date: Nov 2, 2005

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Executive Summary

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

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

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

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

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1. Objectives of the Study

Background

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

Objectives

1.02 The goals of the study are to:

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

1.03 The proposal should also investigate the efficiency, quality and investment incentives of the model and address the Nordic sector-specific challenges like systematic cost differences, environmental factors and differences in accounting principles and legislation.

2. Harmonisation

Current situation

2.01 In NEMESYS (2005a) 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 an ex-ante cost cap component of CPI-X type. At the moment the system does not include a company specific X factor, and hence no benchmarking is included. A reform is underway.
- 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 intended to be more important from 2007.
- Sweden has moved from the light handed ex-post regulation (and an interim price freeze) to use of ex-post technical norm model (Network Performance Assessment Model, NAPM). Concession granting is seen as a long term component in the regulation. A DEA based benchmarking serves for information dissemination purposes.

2.02 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. Table 2-1 summarizes the different approaches used in regulation in the four countries.

Table 2-1. Summary of regulatory approaches used

	Denmark	Finland	Norway	Sweden
Deregulation	1999	1995	1990	1996
Light-handed				1996-2002
Rate-of-return	2000-2003	1996-2004	1990-1996	
Cost cap		2005-2007		
Price cap	2003 -			2001-2002
Revenue cap			1997-2006*	
Yardstick DEA			2002-2006*	
Yardstick Techn.				2003-

2.03 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 applications. 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.

2.04 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. In spite of open and frequent information exchange between the Nordic regulators in FNER and bilaterally, there has been no natural harmonization of the systems.

2.05 Although there have been some attempts to coordinate certain tasks, such as the Nordic DSO benchmarking 2002, data sharing is of limited usefulness as long as the DSO tasks are somewhat different without any estimate of their relative or absolute importance. There are also more practical differences even on the information collection level. Due to historical reasons, division between transmission, regional networks and distribution differs (voltage levels) varies. There are also many other smaller differences in the ways the key indicators are defined. As the time lags in the collection of data are long, this is one practical issue that hinders harmonization and even less formal benchmarking etc.

Value of harmonization

2.06 The **advantages** of harmonization of regulation could lead to

- Improved long term stability and hereby protection of specific investments by making the commitment at an international level
- Better structural adaptation 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 learning across DSOs, regulators, and other stakeholders
- Increased competition for DSO role by making it easier for DSO to offer services in different countries
- Increased EU influence by taking the EU initiative in terms of network regulation, energy market design and coordination.
- 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
- Lower administrative costs for the regulation in the reporting, accounting etc
- Lower costs for regulators to refine tools and instruments for a common model
- Completed Nordic coordination of the electricity market via a semi-structured coordination at DSO level

2.07 There are also some **limitations** to the harmonization approach:

- Causes problems due to sunk regulation costs
- Risk of hampering regulatory innovation
- Time spent to set up and launch, legal and institutional obstacles
- May contradicts current Electricity Acts, preambles or other laws
- Internal DSO conflicts, may overlook regional differences

2.08 Hence, we should strive for an optimal level of harmonization; touching the principles of regulation as to gain commitment, defining a set of common tasks as to improve data quality and gathering costs, creating sound and equal incentives of investment and efficient operation across the region. The harmonization should not limit national prerogatives unnecessarily, force potentially arbitrary institutional reforms upon countries or sacrifice rational national adaptations to operating conditions in order to achieve common standards.

Analyzing the Nordic case

2.09 The Nordic area shows, as shown above, signs of suboptimal costs of regulation at several levels. First, the tasks are defined nationally, if at all, leading to high coordination and information costs. Second, the due to the different approaches and stages of implementation, the Nordic regulation systems provide quite different incentives for DSOs. The incentives for efficiency improvements depend heavily on the possibility to have the improvements that exceed expected level as additional profit. In Finland and Norway this is possible during the regulation period, but the effect on the base line for the next period gives a mixed signal. The effect on the tariff level depends on the tightness of regulation, the clarity of the requirements ex-ante, and the obligation for return excess profits to the customers. E.g. in Finland the last two aspects have been changed and the incentive for tariff changes has increased significantly. None of the countries offer very clear incentives related to security of supply or other quality issues. This reflects the fact that historically the quality issues have been on a very good level. None of the current models provide any clear (wanted on unwanted) signals for consolidation. Finally, and most alarming, the current changing regulatory landscape does nothing to address the poor investment incentives in the sector, where the regulatory risk is evaluated strictly nationally even for consolidated firms.

NEMESYS view on harmonization

2.10 A process of harmonization could significantly improve the Nordic DSO regulation based on the analysis above. Before outlining the process, let us quickly clarify some aspects that are not in the scope of this proposal:

- No creation of regional or European meta-regulator.
- No imposition of common tariffs or delivery conditions across regions

A. Definition of DSO task portfolio

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

1) **Core DSO Tasks** form the least common subset of DSO tasks to be fulfilled by any DSO in the Nordic area and for which common data is collected and common regulation could apply.
2) **Nationally Regulated DSO tasks** are defined DSO activities that are not harmonized in the Core DSO Task but that remain regulatory obligation in at least one country. This could apply to e.g. tasks related to safety inspections, line dismantling and energy planning. All compensation for such tasks should be transparent (and preferably based on tendering) to avoid cross-subsidies to incumbents. To maintain this transparency and promote development, we propose that the regulated payments for the National Regulated DSO Task should be separated from the Core DSO Task. In practice, this could render these tasks more attractive to non-DSO providers or at least informing the regulator of the real costs involved to permit social trade-offs.
3) **Other DSO Tasks** are activities that are not regulated, but compatible with the national and European directive with respect to non-discrimination, independence and competition. In the regulatory regime proposed below, such competitive activities can be freely performed under residual competition law as so far as they bring coordination gains.

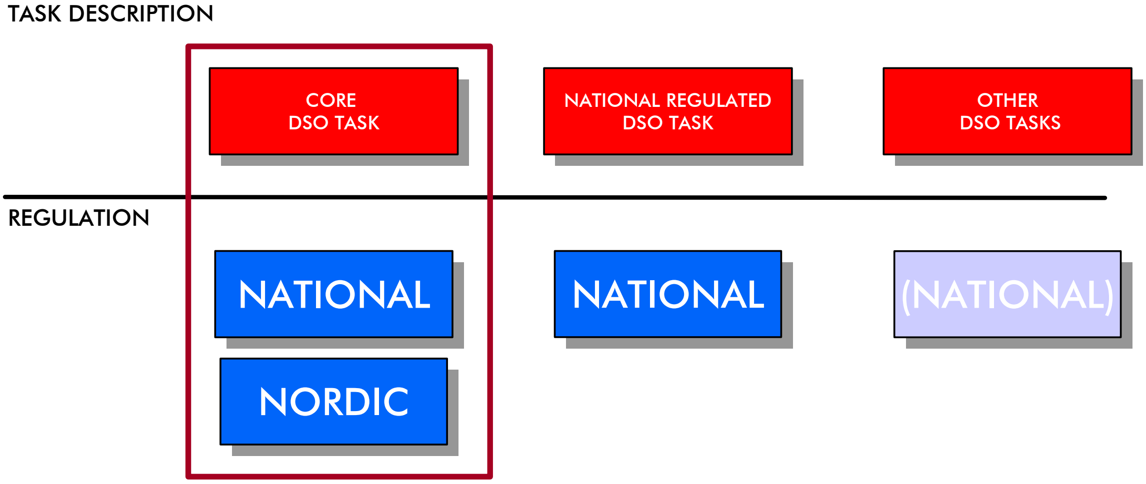

Figure 2-1 DSO Tasks and corresponding reguatltion.

B. Regulation and information harmonization

4) **Framework agreement,** a common regulatory vision statement for both model structure and the time plan need to be agreed upon 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 fully integrated regulatory body like NORDREG could easily administer the regulation, but the proposal is flexible with respect to institutional solution. The competency to define national marginal prices, nationally regulated DSO tasks and to define concession areas is also a national prerogative, as all monitoring of the non-economic and equity aspects of the directive.

5) **Common information system.** Any quality-oriented, output-based regulation needs access to high-quality data in common formats, but so does the sector itself for its coordination and restructuring. We propose a common client metering standard, including format for transmission of hourly data, connection and disconnection. We propose that the meter standard defined by a *Metering Agent*, formally responsible for the metering, reporting and administration of technical data from customer level to other parties.

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

3. Regulatory toolbox

3.01 This section draws on a richer discussion on design of regulatory instruments in NEMESYS (2005b). The practice and theory of network regulation exhibits a plethora of models and approaches, which basically can be classified into five categories of regimes:

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

3.02 NEMESYS (2005b) evaluates the five categories with respect to the overall criteria to find guidance in Table 3-1 for the development of interesting candidates for a common regulation regime. Green areas indicate relative strengths, red weaknesses and yellow aspects dependent on parameters. Two findings are apparent: the behavioral advantages of yardstick and franchising systems and the specific need to address service quality in the regime. On the one hand, the two methods bridge the information gap between the regulator and the firm, in that they form a 'pseudo'-market for the firms. This allows the regulator to concentrate its efforts to areas where it is necessary and relevant, such as monitoring of terms, industry structure and quality development. On the other hand being highly incentivized, their effectiveness depends crucially on the regulatory commitment, which is where the regulatory integration comes into play. The investment incentives crucially depend on the parameters and regulatory commitment to the system, they can be either very good or very poor. In NEMESYS (2005b), this analysis is taken as a starting point to develop in more detail alternatives for quality, yardstick and franchising regimes.

Table 3-1 Comparison of model alternatives.

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

Dynamic cost-based yardstick

3.03 Dynamic yardstick schemes based on Data Envelopment Analysis (DEA) solve many of the usual CPI-X problems, including risk of bankruptcy with too high X, risk of excessive rents with to low X, ratchet effect when updating X, arbitrariness of the CPI measure, arbitrariness of the X parameter, and inability to include changing output profiles. The most important difference between a yardstick schemes and a more traditional CPI-X regime is that the firms are compared to actual cost frontiers rather than projected cost frontiers. This reduces the informational and analytical requirement put on the regulator and allows for a more precise inference of actual performance. It hereby also allows for better incentives. The business risk is not increased as revenues follow more closely cost development

Dynamic revenue-based yardstick

3.04 To address get rid of the input-dependency of the previous regime and in particular the capital evaluation problem; NEMESYS (2005b) presents an innovative model based on net revenues rather than costs. 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. DSO charges are set by all firms and regulated afterwards 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.

3.05 The basis for the dynamic revenue-based yardstick is still a benchmarking or frontier model that calculates for a given level of output in all its dimensions, taking into account the operating conditions, efficient revenue by a comparable operator. The positive or negative difference between the efficient revenue and the actual revenue charged becomes a *carry-forward* that is to be repaid or charged with interest rates, just like a loan to and from the rate payers. Since the total relevant cost includes all operating, capital and financing charges, cost pass-through can be limited to standard costs for net losses, transmission charges, non-distribution tasks and taxes.

Dynamic Network Auction Model

3.06 The strength of 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. A new model in NEMESYS (2005b) solves the residual benchmarking estimation problem by a repeated auction design.

3.07 Briefly, in the dynamic network auction model the DSOs tender for the fixed tariff in their concession area, knowing that their variable tariff will be regulated as in the dynamic revenue-yardstick above during the duration of the license. In this way the consumers are assured to get higher competition for the market, while still being protected from any attempt to recover an artificially low fixed tariff by an inflated variable tariff. On the other hand, the firm is protected by the fixed component against possible systematic errors (up or down) in the yardstick model. In case the operating conditions are understated in an area, the DSOs would require an extra payment; if they are less severe they may even pay to get the license.

Quality regulation model

3.08 As discussed above and in NEMESYS (2005a, 2005b), 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. First, supported by the theory and the scientific consensus of SESSA (2005), we conclude that a regulation for electricity distribution that is entirely restriction-based is likely infeasible in the long run. However, the large number of measurable dimensions suggests a hybrid approach using restrictions, since many of them are correlated to reliability of supply. Thus we argue for the explicit inclusion and marginal pricing of reliability of supply. Other quality aspects, related to voltage and commercial quality, are proposed to be defined with target and threshold values in the DSO Task Description, preferably jointly with clients and industry organizations.

4. The NEMESYS Approach

4.01 The approach, fully documented in NEMESYS (2005d) is composed of two elements: the *Revenue Yardstick Model* and the *Quality Incentive Scheme*.

Revenue Yardstick Model

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

4.03 This is done by invoking a two year delay which enables 1) the DSOs to do their financial accounting in the usual way, 2) the regulator to have time to collect and process tariff and service data, and 3) the consumers to know tariffs a priori.

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

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

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

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

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

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

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

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

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

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

4.08 In period t the actual charges of the DSO is

$$AC(t)$$

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

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

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

Example

4.09 To illustrate the mechanics, consider a case with three DSOs that have so far in each and every period charged 100. Let the interest rate is α=5% and the penalty rate δ=5%. The development in underlying minimal costs is illustrated in *italics* and the chosen DSO charges are illustrated in **bold** in the Table xx below. We see that DSO Two faces idiosyncratic extra costs of 10 in Period 2 and that DSO Three tries to use its relatively low costs to get extraordinary profits.

4.10 The example not only illustrates the formula. It also illustrates that companies carry their idiosyncratic risks, are ensured against general variations in costs and that there is pressure on the DSOs to reduce charges to the minimal level that covers all costs, including capital costs.

Table 4-1 Example

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

The intuition

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

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

4.13 The revenue yardstick scheme is illustrated in Figure 4-1 below. The minimal costs of an efficient DSO is below the yardstick level as indicated with a non-filled point, but the DSO can choose to charge the consumers more or less as indicated by the solid points on the vertical line through the minimal cost point. Overcharging occurs when the charging exceeded the yardstick level.

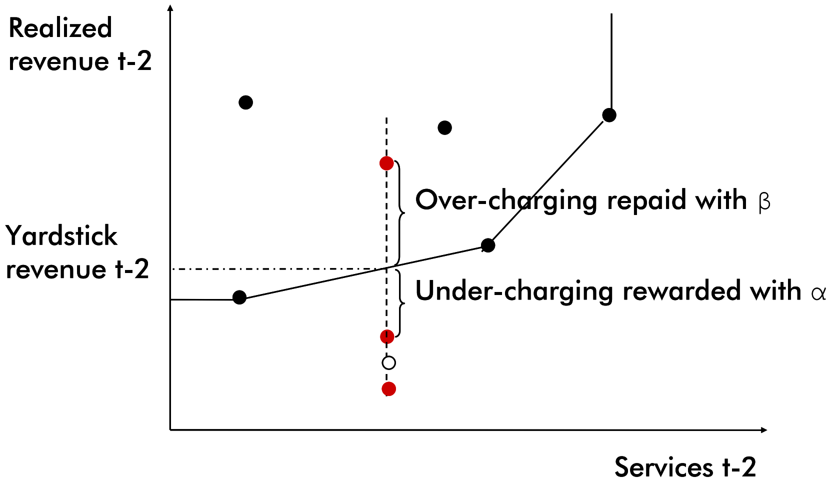

Figure 4-1 Yardstick revenue scheme

Incentive effects

4.14 The proposed scheme gives the DSOs incentives to participate and to reduce tariffs to the smallest level that is consistent with continued operation. In short, the mechanics is based on rational forward-looking decision making, where a DSO would not charge lower tariffs than what corresponds to continued operation, including reserves for future investments and a fair long-run average rate of return. The difference is particularly visible for old networks before reinvestment or expansion, where an input-based regulation (using some book-value estimate of capital) would artificially "strangle" the build-up of reserves prior to investment, later to hike tariffs up after the investment. In the new model, this problem disappears as it is the value of continued operation, the tariff, that is evaluated, not the age or state of its assets.

Benchmarking model

4.15 The benchmarking model is the engine in the yardstick model to determine C* for any kind of DSO; rural or urban, with any kind of service profile, mix of high voltage/low voltage. NEMESYS (2005c) is entirely devoted to this model, for which we briefly touch the specification and the choice of model below.

4.16 In the *specification*, the model should take into account inputs, outputs and environmental conditions. On the input or cost side, we need the *revenue levels*. Since the total relevant cost includes all operating, capital and financing charges, cost pass-through can be limited to standard costs for net losses, transmission charges, non-distribution tasks and taxes. On the output or *services* side the scientific as well as the technical literature converges on a specification that reflects three dimensions: (customer service, transportation work and capacity provision. The first dimension is usually covered by the total number of clients, potentially divided into voltage levels or market segments. The second corresponds to total delivered energy, if needed differentiated by voltage level. The third dimension is covered by proxies for capacity such as installed transformer power or peak power. Environmental conditions can be covered by network length (all studies), delivery area (UK), climate zone (prev SE) or other proxies, cf. Agrell and Bogetoft (2000, 2005) or NEMESYS (2005c).

4.17 Concerning the *type of model*, the NEMESYS study (in particular subproject C), draws on the economic optimality and international experience of the Data Envelopment Analysis (DEA) model for network regulation, already in regulatory use in NO, SE and FI. The model has the advantage of giving a conservative estimate of efficiency and draws on a solid production economic base. However, other models can also be applied, from simple partial averages (€/kWh delivered, etc), linear cost functions (e.g. based on simple linear regression), or more advanced frontier functions such as Stochastic Frontier Analysis (SFA, cf Agrell and Bogetoft, 2005). Although frontier models as DEA appear as more complex than e.g. average cost functions, the consequences of the simplicity on firm revenue in a multi-output service can be considerable, both up and down.

Quality incentive scheme

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

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

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

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

Compensation scheme

4.21 The structure of the quality incentive scheme is simple

$$Q = A + p^*q$$

4.22 where Q is the quality payment to the DSO, q is the supplied level of quality dimension, and A is a fixed payment. The quality reimbursement shall be added to the allowed revenue according to the revenue frontier yardstick model to form the full regulated revenue to the DSO. Specifically, this can be done by including the positive or negative quality charges in the carry forwards into a carry forward with quality CFwQ so as to settle these with a two year delay.

1) **Base level A** is the preferred equilibrium point (base level) of ENS and SAIFI is to be determined once for each operator and concession area, without updating, using statistical, technical and socio-economic analysis. In the analysis care should be taken to include the environmental, load and service factors that have an impact on historical reliability. The optimal levels, the base levels, trade off the benefits to consumers against the costs to the DSO of providing quality. The base levels will depend on the country, connection level and the DSO, but have no link to historical levels of cost or performance.

2) **Marginal price p** is defined without ambiguity based on type of connection, for each customer segment by the regulators for a ten-year period (cf. Figure 4-2) per unit of energy not delivered (ENS) and outage occasion (SAIFI), for notified and non-notified interruptions, respectively.

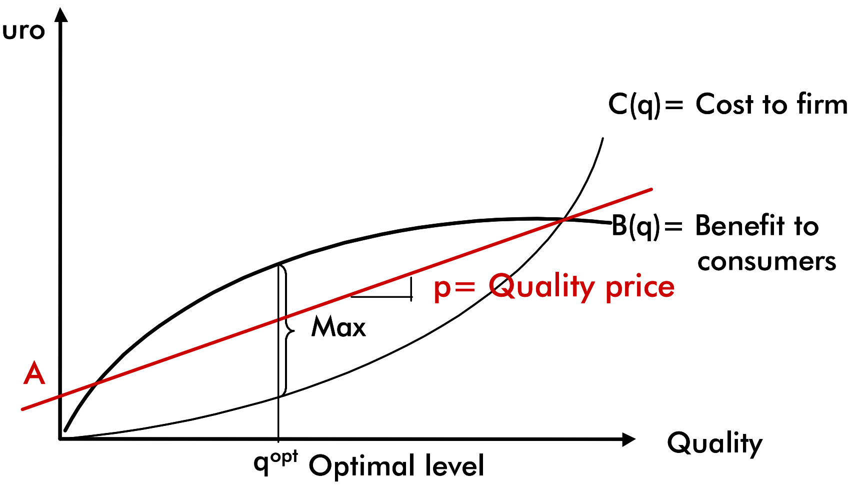

Figure 4-2 Quality regulation

Regulatory settlements

4.23 Based on objective and verifiable measurements of ENS and SAIFI at customer level compensations to individual customers can be calculated and the customers can be reimbursed with a time delay corresponding to the one used in the revenue regulation. To the extent that ENS and SAIFI cannot be measured and controlled at customer level, then the lowest, most customer close measure points shall be used. In these points, the ENS price will equal an average of the consumer based prices below while the SAIFI price will be the sum of the SAIFI prices for the customers below. To avoid unnecessary administrative burdens, small consumer reimbursements could also be accumulated on a solidarity account and be used to lower the general charges to the DSO's consumers.

Regulatory procedure

4.24 The proposed regulatory procedure is illustrated in Figure 4-3 below for the three parties DSO, regulator and metering agent.

1) **DSO** reports electronically financial, service and concession data for *Core DSO Tasks, National Regulated DSO Tasks,* and *Other DSO Tasks*, after closing the accounts for year 1.
2) **Metering Agent** reports low-level reliability data for year 1 and total supplied energy from higher grids.
3) **Regulator** calculates DSO Net Revenue by deducting for the preceding year, charges to higher grids, standard costs for network losses, *National Regulated* and *Other DSO Tasks* from the submitted total revenues. If the Net Revenue is negative, the firm is deleted from the list of comparators, otherwise not.
4) **Regulator** runs revenue yardstick model is run for all firms, using the eligible comparators, and the Efficient Revenue for year 1 is calculated for each firm.
5) **Regulator** calculates the quality incentive scheme and the result can be either negative or positive. In the first case where less than optimal quality has been supplied, the result shall be processed as an ENS compensation to be paid out to consumers in year 3. To limit the administrative burdens, we may choose only to compensate individuals when the compensations exceed a given threshold, and to simply pool small amounts and use these to compensate the collective of consumers. In case of positive quality outcomes, i.e. when the supplied quality level exceeds the base level, we propose to simply charge the consumer collective in year 3.
6) **Regulator** announces the Carry-forward for year 1, including the negative or positive difference from the revenue yardstick and the pooled difference from the quality incentive scheme, is to the DSO for settlement in year 3.
7) **DSO** incorporates the Carry-forward for year 1 in the establishment of tariffs and a projected budget for year 3. The tariffs and the projected budget are submitted to the regulator as an acknowledgement of the Carry-forward.
8) **Regulator** formally approves (orthodox ex ante) the proposed tariffs for year 3. In this step, discretion may be exercised based on e.g. upcoming investments in the budget and negative Carry-forwards.

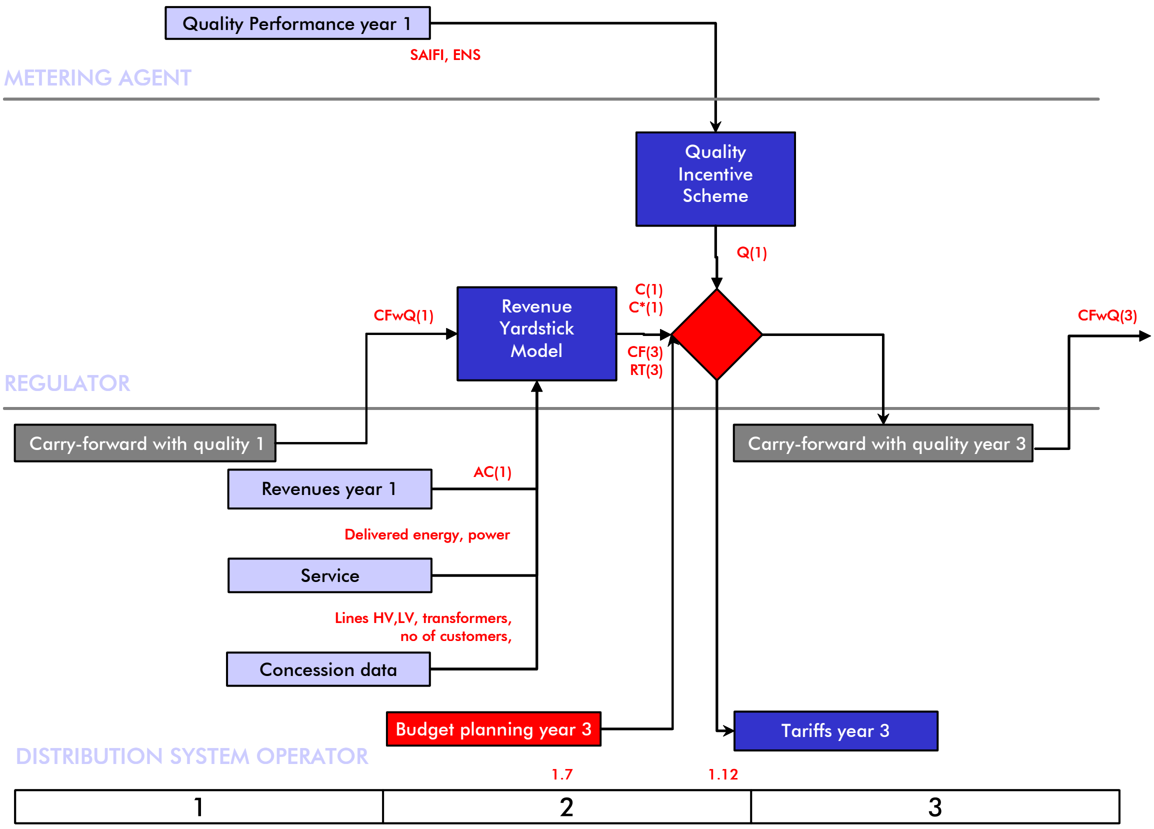

Figure 4-3 The NEMESYS regulatory procedure.

5. Stakeholder analysis

5.01 To investigate whether the institutional differences in regulation reflects underlying national differences in preferences and prioritization, the project collected structured data on the goals and objectives of different stakeholders (DSOs regulators, government, industrial clients, residential clients, associations) in the four countries. The study NEMESYS (2005a) comprised both questionnaires and semi-directed interviews of the group.

Results: Stability, quality and efficiency

5.02 The survey and interview material show that different stakeholder groups are to large extent very unanimous about the goals and objectives related to electricity distribution (cf Figure 5-1). Most important economic aspects are stable tariffs (clients) and stable return on investment (owners), and high efficiency. Natural conflicts are related to the level of tariffs and profits. Quality aspects are as important as the economic aspects and security of supply is the most important single goal. Other studies TNS Gallup (2005a and 2005b) confirm increasing orientation towards customer service and reliability of information from the sector. Many clients are also uneasy with the basis and justification for the distribution tariffs, suspecting inefficiency. Equity and fairness issues, in particular open network access, are mostly seen as requirements but not primary goals. Depending on the stakeholder groups, equity of customers and fairness for different types of companies are also seen important. Social and environmental aspects are ranked less important for network regulation.

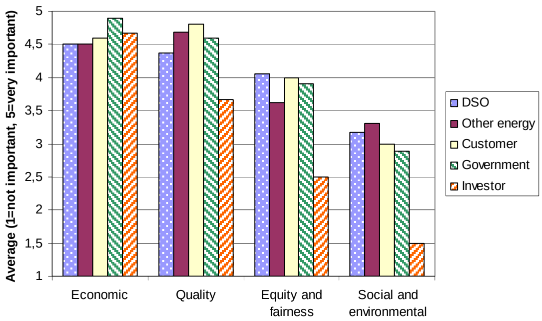

Figure 5-1 Relative importance of DSO service dimensions under well functioning regulation

Stakeholder consequences

5.03 Summarizing a richer consequence analysis for firms, customers, market and government in NEMESYS (2005d), the most important changes would be related to the incentives for lowering tariffs and improving cost efficiency. The suggested mechanism would set a high cost reduction and tariff cut pressure on those companies that are classified as inefficient. This would have a very significant local effect, and it would probably lead to structural changes in the industry. On the other hand the efficient companies would probably make more profit than under the current regimes. Hence the suggested approach would give much stronger incentives for improving efficiency and generating investments. In the short run the suggested mechanism would decrease the stability of tariffs and profits, but in the long run it should lead to a stable situation.

6. Further actions

6.01 Many detailed questions remain before an actual implementation of either harmonized regulation or the specific proposal. Below we specify a prioritized list of suggested further actions by Nordenergi. Note, however, that these projects in no way can or should substitute for development work made directly by, or for, the regulators. The active involvement of the sector in the development and convergence of regulation enables and facilitates the necessary implication of the national institutions. To strengthen the involvement the further work should be centered on three themes: internal development, enablers, and principal challenges.

A. Nordenergi development phase

6.02 For NEMESYS to emerge as a common proposal from Nordenergi:

1) **Information** about the proposal and its properties should be disseminated to all national members and chapters of Nordenergi to ensure that the proposal is well understood among the membership. The ensuing internal debate may then detail, improve and develop the approach to facilitate its implementation.
2) **In-dept quantifications of the consequences** for the grid companies of changing the regulatory design from the current national regulatory models to the by the working group preferred Nordic regulatory model. The analysis should include quantifications for different types of grid companies as well as an industry-wide quantification. The pilot study should primarily be based on historic data from the ex post regimes in Sweden and Finland, possibly amended with observations from Denmark that lie below the stated revenue cap.
3) **Live simulations** should be done to explore the yardstick logic using a "virtual laboratory" with real decision makers subject to a dynamic simulation. The purpose of these exercises is to train the decision makers in the *new logic* rather than a specific application and to collect data on behavior to facilitate parameterization.

B. Initiative on regulatory enablers

6.03 From the harmonization enablers mentioned above, Nordenergi could pursue:

1) **Task definitions** among the membership countries as to determine a possible set of core DSO Tasks, including a set of indicators to measure the output of the tasks if necessary.
2) **Data harmonization** should be defined in collaboration with regulators as to converge on data collection routines, metering standards, information systems, definitions and standards that permit pan-Nordic open information systems.

C. Principal challenges in the model: Non-profit firms

6.04 The application of a high powered regime (such as the proposed yardstick) to non-profit maximizing firms would need specific instruments to control for their impact on the revenue norm. ***A specific study should be conducted on (i) the prevalence and behavior of non-profit firms and (ii) an in-depth investigation of validate the accommodation of such firms in yardstick competition***.

7. Conclusions

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

7.02 The **harmonization** of DSO tasks, defining responsibilities, data and compensation norms clearly across the Nordic countries leads to a more transparent and constructive dialogue with regulators. Further harmonization of regulation principles, instruments and regimes improves both the *effectiveness* of the regulation, by commitment to the key issues rather than details, and the *efficiency* of the sector in the creation of equitable, stable and sound business conditions under lower regulatory risk premiums.

7.03 The **yardstick idea** is practically implementable, compatible with the Directive and open for several types of cost functions. It leaves the difficult problem of asset valuation and to the DSOs and the capital market. It also combines 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 parameters can be set to "tune" the regime to different capital risks.

7.04 The **quality incentive scheme** supports the optimal trade-off between cost and benefits of security of supply. Moreover, it provides quality incentive for DSOs irrespectively of their performances in the revenue yardstick competition. That is, even inefficient DSOs are encouraged to care about security of supply, investment analyses on quality provision can always be performed, irrespective of profit level.

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

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.