# DISTRIBUTION NETWORK OPERATOR REGULATION – A TASK-ORIENTED APPROACH

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## *ABSTRACT*

*This paper describes the use of so called norm costs in the new distribution system income cap regime to be launched in Norway from January 1st 2007. The norm cost should in principle represent the efficient cost level (market price) for providing the distribution network services in a given area. The Norwegian regulator (NVE) has decided to establish norm costs using DEA benchmarking.*

*The DEA approach has some significant drawbacks which has been the motivation for developing an alternative task oriented model. In the proposed alternative model the Distribution Network Operator (DNO) norm cost is divided into five partial norm cost elements. The paper presents how these partial norm cost elements can be established and discusses advantages and drawbacks compared to establishment through DEA benchmarking.*

## INTRODUCTION

For the Norwegian electrical transmission and distribution sector income cap regulation was introduced in 1997. In this model the Regulator is granting a maximum permitted income for the utilities separate from their actual costs. Company performance (efficiency) evaluated by Data Envelopment Analysis (DEA), has had a direct effect on the permitted income – both in the first income cap regulatory period 1997-2001 and the second 2002-2006. The efficient DNOs has had a smaller cost reduction requirement than the inefficient ones.

From 2007 a new regulatory period will start. Two main changes have been decided:

- The total income cap for the Norwegian DNOs will be equal to the total costs - including depreciation costs and a regulated rate of return
- Norm costs will be used to divide the total income cap between the companies.

The regulator (NVE) has decided to establish the DNO norm costs using DEA benchmarking, which has been disputed by many parties in the public enquiry prior to NVE's decision.

The task oriented approach presented in this paper is developed as an alternative to the DEA based norm cost scheme. The main motivation has been to avoid as many as possible of the identified drawbacks of the DEA based approach without introducing too many new ones.

## PRINCIPLES IN THE NEW FRAMEWORK

The total income cap for the Norwegian DNOs is given by:

$$IC_{tot} = \sum_{i=1}^{n} K_i \qquad (1)$$

where

| | |
|---|---|
| $K_i$ | - Annual costs for utility 'i' |
| n | - Total number of DNOs |

The allocation of the total income cap between the DNOs is in principle determined by eq. (2) giving the ex ante income cap for company 'i' in year t:

$$IC_{i,t} = \alpha \cdot K_{i,(t-2)} + (1-\alpha) \cdot K_i^* \qquad (2)$$

where

| | |
|---|---|
| α | - Weighting factor (0%≤ α ≤100%) |
| $IC_{i,t}$ | - Income cap year t |
| $K_{i,(t-2)}$ | - The DNO's costs in year 't-2' |
| $K_i^*$ | - The norm cost for the DNO in year 't' |

The *t-2* stems from the regulatory reporting time lag.The costs $K_{i,(t-2)}$ and $K_i^*$comprise the following:

- operation and maintenance costs
- cost of customer management
- cost of electrical losses
- depreciation costs
- regulated return on assets (historic book values) using the NVE regulated rate of return
- CENS i.e. Costs of Energy Not Supplied

So the overall principle is that a part (α) of the DNO's income will be decided by the DNO's own costs (including regulated return on assets and customer outage costs) while the reminder (1- α ) will be decided by the norm cost $K_i^*$. The factor α is set by NVE to 50% in 2007 /2008 and to 40% from 2009 – i.e. the norm cost will have an increased weight after an "introductory" period.

An important prerequisite is that the average capital rate of return for the whole industry should be equal to the NVE regulated rate of return. The total norm cost $K^*$ will be adjusted accordingly to meet this requirement. This requirement leads to the situation that total income for the Norwegian DNOs will be equal to the total costs. But the rate of return for the individual companies might be very different. The expectation values for 2007 rate of return (based on 2005 costs and asset base) varies between 2%-12% (excluding some special cases).

How to determine the norm cost $K^*$ is obviously the main challenge in this regulation.

## DEA BASED NORM COSTS

In general many DNOs have favoured an increased norm element in DNO regulation. So the main principle is hence positively received. NVE will use DEA benchmarking to assess the norm cost. A simplified description of the method is given by the following example:

Utility 'i' has a total cost of $K_i$=100 Mill. NOK in 2005. The DEA score for the utility is 80% meaning that the utility is using 20% "too much" resources to provide the DNO services compared with the efficient companies forming the efficiency frontier. To make the total norm cost equal to total cost (inclusive an extra compensation for realised asset investments), the determined efficient cost will be divided by the average efficiency score for the whole industry (about 90%). The cost norm $K_i$* is hence estimated as follows:

$K_i^* = K_i \times DEA_{score} / DEA_{ave} = 100 \text{ mill NOK} \times 0,8/0,9 = 89 \text{ mill NOK}$

Many utilities have expressed scepticism to the use of DEA benchmarking to determine the norm in this way. The drawbacks listed are mainly the following:

- DEA is not a transparent tool which is easily understood and recognized.
- Model design heavily influences the benchmarks and hence the norm cost on company level
- Environmental factors (geography, topography, climate,..) that might contribute to utility costs is especially challenging to model
- To prove that a certain model is fair and "good enough" is difficult (i.e. to separate differences in efficiency from systematic differences in data quality and model inaccuracies)
- If a reference utility postpone a task from one year to the next – the efficient cost for that task might be zero for the relevant year
- Strategic cost allocation (accounting) between sub-transmission system and distribution system is an opportunity and a problem.
- Special utilities might shape the frontier not because they are efficient, but because they are special
- The same project will have different rates of return depending on the company implementing it.
- Cost effective mergers might not be economical
- The historic and proposed use of the DEA have not explicitly accounted for model inaccuracies
- To model aspects that relates to system topology and location (point of connection) for loads and generation is not yet solved in the DEA models tested in Norway or in other Nordic countries.

A small example below illustrates the last problem.

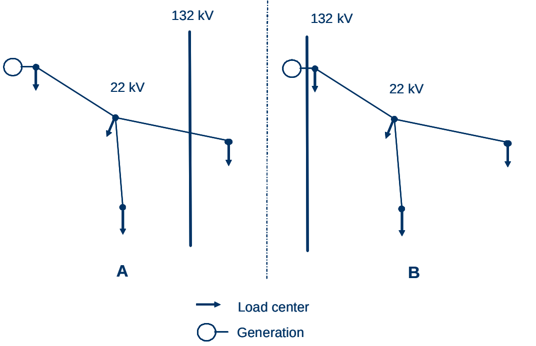


**Figure 1 Influence of system topology and point of connections – different location of 132 kV grid**

The DEA models used so far, will describe the situations for company A and B shown in figure 1 as the same supply situation. But as the sub-transmission line location is quite different in the two cases, the supply task will be different in reality– especially when it comes to outage costs, electrical losses and component dimensions. And as the cost of losses and the outage costs amounts to approx. 20% of the total costs, the uncertainty is substantial.

## A TASK ORIENTED NORM COST MODEL

The main idea with this model is that the DNOs should have a fair compensation for the tasks that they have to carry out. These tasks are mainly defined in the laws and regulations. In the DEA model all tasks are summed up in a "black box" making it difficult to evaluate the effect of improvements and if the efficiency frontier for a specific task is within reach, when applying best practice.

System layout is the product of detailed local planning of the distribution system taking into consideration aspects and parameters far beyond what can be included in a DEA model. In the task oriented approach it is assumed that system configuration is adequate and hence the utility should have the required means to manage the assets. It is also from the reasons stated previously questionable to decide the optimal level of outage costs and costs of electrical losses based on comparative benchmarking with other utilities.

Though incentives must be given to strive for the overall minimization of the overall supply costs, but this precondition is largely present when internalizing all costs (including the costs of quality of supply). As the income cap and the actual internalized costs are somewhat decoupled, incentives for overall cost cutting exist (when feedback mechanisms for updating the income cap are well designed).

The proposed task oriented model aims at a more transparent establishment of the norm cost $K^*$ through a set of partial norm costs.

The main principle is given by (3):

$$K^* = K_{ncustomer} + K_{ncapex} + K_{xopex} + K_{nlosses} + K_{nCENS} \quad (3)$$

where

- $K^*$ - Total norm cost for a DNO
- $K_{ncustomer}$ - Customer management norm cost
- $K_{ncapex}$ - Capital norm cost
- $K_{nopex}$ - Operation and maintenance norm cost
- $K_{nlosses}$ - Electrical losses norm cost
- $K_{nCENS}$ - <u>C</u>ost of <u>E</u>nergy <u>N</u>ot <u>S</u>upplied norm

A norm in this context might be:

I. An overall norm for a specific task i.e. norm for the total costs of the task
II. A Unit norm cost for a specific task i.e. total task costs are derived by multiplying a unit norm cost with number of units

As an example of the type II the norm cost for customer management can be estimated by multiplying the number of customers, $n_{cust}$, with a unit norm costs $C_{unit}$:

$$K_{ncustomer} = n_{cust} \; x \; C_{unit} \quad (4)$$

Table 1 summarizes the options considered with respect to establishing each partial norm.As the regulator doesn't yet have the necessary information to reveal the norm for losses and energy not supplied, a cautious first step approach proposed is to give the DNOs cost recovery for both the cost of losses and the outage costs.

Table 1 Partial norm cost elements

| Norm cost element | Comment |
|---|---|
| $K_{ncustomer}$ | As customer service processes are largely electronic or mail based, it is anticipated that both total norm costs and unit norm costs are applicable. |
| $K_{nopex}$<br>$K_{ncapex}$ | Norms are credible with respect to the actual infrastructure the DNOs have. To reveal inadequate topology through benchmarking is not within reach without detailed system analysis – hence unit norm costs is the preferred for both opex and capex |
| $K_{nlosses}$<br>$K_{nCENS}$ | Difficult to establish norms for topology and connection point reasons. Inadequate loss level or CENS level can only be revealed by power system planning tools. Both type I and type II partial norms are difficult to establish |

For the other cost elements the following methods developed and further described in [2]:

Table 2 Proposed methods for partial norm cost estimation

| Cost element | Norm cost estimation – methods developed |
|---|---|
| $K_{ncustomer}$ | • A partial DEA benchmarking model<br>• Normalized customer object method |
| $K_{nopex}$ | • Normalized Network Object method |
| $K_{ncapex}$ | • Annuity of the system replacement value using market based unit prices. |

The efficiency incentives by using this approach to determine $K^*$ stems from one of the following:

- Using a partial DEA models
- Using best practices unit prices giving incentives to use the best practice and to improve best practice

As more utilities use service providers for a number of tasks, market prices for different tasks and jobs will be more transparent also for the regulator. Both in principle and in practice the proposed scheme will have several advantages - which might be strengthened by the ongoing reengineering processes in the industry.

## OPERATION NORM COST

To illustrate some features in this model, the estimation of $K_{nopex}$ using the proposed Normalized Network Object Method is given. This approach is equivalent to the Normalized Customer Object Method proposed for estimation of $K_{ncustomer}$.

The method takes advantage of previous work concerning maintenance resource estimation and benchmarking.

The principle is illustrated in figure 2:


**Figure 2 The NNO Principle**

The resources needed for best practice maintenance of each network object is measured in a common unit NNO – Normalized Network Object. This is a relative unit – in the figure the NNO reference is 1 km of 22 kV overhead line in a normal environment. The substation represents 50% of the maintenance costs, while the cable cubicle represents 1%. (The figures are illustrations only).

The weighting is based on detailed unit prices for different maintenance tasks – see example below:

Table 3 Example of NNO unit cost estimation base

| Maintenance Action | Man hour costs | Material | Total (NOK) |
|---|---|---|---|
| Substation Inspection | 150 | 0 | 150 |
| Circuit breaker operation | 300 | 0 | 300 |
| Cable voltage testing | 300 | 0 | 300 |
| Earth resistance measurement | 600 | 0 | 600 |
| Transformer oil refill | 600 | 50 | 650 |
| etc | ----- | ----- | ------ |

By summarizing Normalized Network Objects, an overall index for maintenance requirements can be estimated both at utility level and national level. Figure 3 shows an estimate of the NNO index on a national level (Norway).

By using best practice unit prices – i.e. achievable market prices, the NNO index represents a fair evaluation of the efficient maintenance burden for each company and should hence be a good approach for opex norm cost formation. Another advantage is that the method is transparent and easy to understand – i.e. easy to recognise and evaluate from a utility's perspective. With more service providers in the market, market prices will also be more transparent. Separate norm cost formation of the LV/MV and HV grid is avoided using this approach.

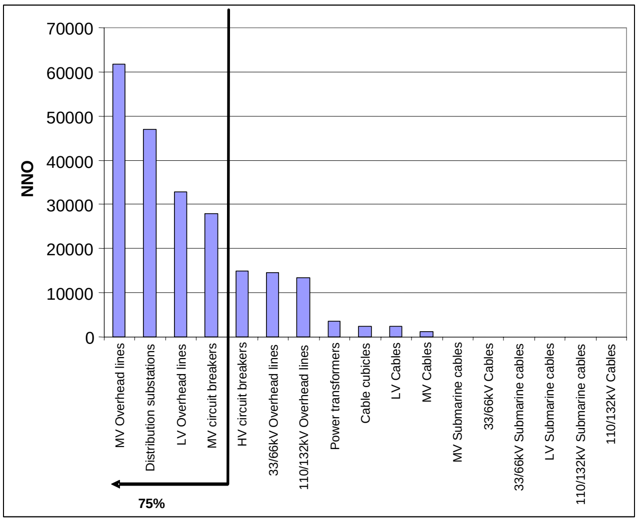


**Figure 3 Total NNO Index example for Norway**

## CONCLUSIONS

The proposed principle has been investigated and the findings in the project shows that such norm costs can be established. It is possible to go to great detail in the modelling of asset management and customer tasks in different environments and it is possible to use a more aggregated approach. Detailed studies are used to evaluate what level of aggregation that might be acceptable. The advantage of the method is that it is more intuitive from an industry point of view, and the parameters are more transparent than in the holistic DEA approach. Hence it gives a better link between DNO tasks and DNO regulation. As utility income and costs are partly separated the utilities will always have incentives to reduce costs if the feedback from cost reductions to utility income is reasonable. By using partial DEA models and best practice unit prices the DNOs have incentives to use best practice to get their fair share of the overall industry income.

The method has the disadvantage of not being able to reveal inefficiencies in system layout. In principle the DEA approach does not have this disadvantage, but in practice a "good enough" DEA model is hard to establish for norm cost use.

## REFERENCES

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[2] Kjell Sand, Dag Eirik Nordgård, Knut Samdal, 2006
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