MEANS FOR COST EFFECTIVE USE OF TOOLS FOR PLANNING, OPERATION AND MAINTENANCE

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SUMMARY

A large number of different information systems combined with manual data archives are used within each electricity utility for planning, operation and maintenance. There may be large potentials for cost reductions by a more effective utilization of the different tools and by providing better data basis and methods. These aspects represent the background for an ongoing R&D project. This paper reports from this activity. Potentials for increased effectiveness and cost savings by digitalization of data and utilization of NIS are illustrated by including some results from a cost-benefit analysis performed at a large electricity utility in Norway.

1 INTRODUCTION

Introduction of deregulated power markets and stronger regulation of the transmission and distribution (T&D) system has led to increased focus on cost-effectiveness and increased demand for documentation of various aspects concerning planning, operation and maintenance of transmission and distribution systems (T&D).

A large number of different information systems are used within each electricity utility, such as customer- (CIS), network- (NIS) and geographical information systems (GIS), fault and interruption statistics (FIS), simulation tools etc. These systems are usually not integrated and they hardly communicate with each other. In addition there is a lack of relevant data and methods, especially at the lower voltage levels. As a result a large amount of manual work has to be done. Organizational obstructions are other aspects coming into focus.

This situation which seems to be typical also in our neighbouring countries [1], may have been satisfactory in the past. However, new requirements and increased demand for documentation together with cost reductions, obviously calls for increased awareness of the utilization of computer tools and data basis. An example is the increased focus on the quality of supply. Some countries have introduced quality regulations, such as performance-based remuneration or financial compensation to the customers for power supply interruptions. For instance, the Norwegian electricity utilities will from year 2000 be obliged to pay compensation for energy not supplied (ENS) to their customers. This kind of arrangement demands a comprehensive amount of documentation such as which customers are affected by interruptions, computation of ENS etc, involving various information systems.

There may be large potentials for cost reductions by a more effective utilization of the different tools and by providing better data basis and methods for tasks concerning planning, operation and maintenance. These aspects represent the background for an R&D project with the main objective to contribute to an effective and optimal use of the various tools. This paper reports from this ongoing activity. An example of cost-benefit analysis is included, performed by one of the largest electricity utilities in Norway. Improvements can for instance be achieved through a better utilization of the existing network, by more proper decisions, more effective planning and operation, but not the least organizational changes.

The paper is organized as follows. A short description of the research project is given in section 2. Section 3 presents the results from a survey of computer tools and data basis among the Norwegian electricity utilities. Information models are described in section 4 with emphasis on the compensation for energy not supplied. Examples from the mentioned cost-benefit analysis are given in section 5.

2 RESEARCH PROJECT

The research project is a part of a 5-year project called “Information and Communication Systems for Electricity Utilities” [2], which also comprises a project concerning rational handling of metering and settlement information. The project is carried out at SINTEF Energy Research in close cooperation with Norwegian electricity utilities. The Norwegian Electricity Federation is coordinating the financing and steering.

The main focus of the project is the different tasks and the type of data, analyses and documentation involved. In the first phase of the project a superior description is made of the main requirements and major tasks concerning planning, operation and maintenance in general. The description is a basis for a detailed identification of tasks,

where planning and design, and compensation for energy not supplied are selected for further detailed analysis.
The main activities are as following:

- Information models – description of tasks, functions and input/output
- Technical and economical data basis
- Cost-benefit models for utilization of information systems for planning, operation and maintenance

The project has in 1998 provided a catalogue of component's costs. This catalogue is designed for planning purposes and contains aggregate costs for different types of components. An information model for compensation of energy not supplied is outlined in section 4, while examples of cost-benefit analysis are given in section 5.

3 SURVEY OF COMPUTER TOOLS AND DATA

A survey of computer tools and data was carried out throughout spring and summer 1998. It was performed as a postal survey consisting of a questionnaire, a guide and a list of computer programs/program vendors. It was sent to all electricity distribution companies in Norway (about 180).

88 companies responded, representing about 65 % of the total number of 2.3 million end-users in Norway. The companies were divided in three categories, Large (> 30 000 end-users), Medium (10 000-30 000 end-users) and Small (<10 000 end-users) with a collection of 13, 25 and 50 in each group respectively.

The goals for the survey was to find out:

- What kind of computer tools do the network owner have?
- How are the tools being used?
- How is the quality and availability of the data involved?

The questionnaire consisted of two parts, one concerning what kind of computer tools the network owners have or use, and one part where the respondent was asked to evaluate the quality and availability of the data involved.

Computer tools

The distribution of the different types of computer tools is shown in Figure 1 while Figure 2 shows the number of companies that have specific analysis/computation tools. Most companies (60-100%) have one of the following systems: Network- (NIS), geographical- (GIS), customer- (CIS) and fault and interruption- (FIS) information systems. Only 35% of the companies have specific tools for handling of component costs.

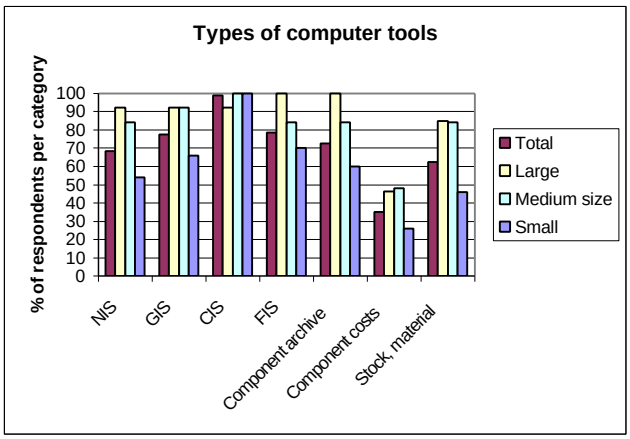

Fig. 1 Percentage of respondents per category with different types of computer tools.

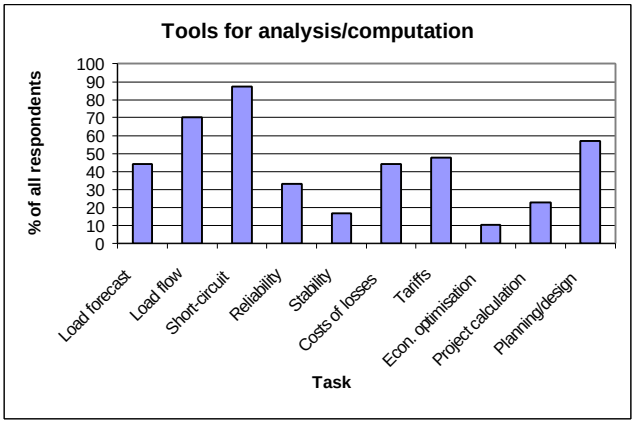

Fig. 2 Percentage of all respondents with specific analysis/computation tools.

Results from the survey showed that the companies to a great extent use function-specific tools. Thus, there are various tools for solving different tasks within each company. The number of companies which have specific computer tools are strongly correlated with the size of the companies. The larger companies have to a greater extent specific tools for the different tasks than the small and medium size companies. Another observation is that the larger companies have mainly chosen their tools from the same software vendors while those of the smaller companies who have specific tools have chosen among a wide range of products/vendors.

Quality and availability of data

The respondent was asked to give an evaluation of the following data:

- Geographical data
- Topological data
- Load data
- Property data
- Status of breakers and connectors

In addition the respondent was asked to give information of how the data was stored, on paper or digitalized. All answers were given for six system levels: Subtransmission, Transformer station, Medium voltage distribution, Distribution transformer, Low voltage distribution and Distribution board.

The portion of data digitalized is correlated with the system level. For the highest level (Subtransmission) about 65% of all data are digitalized while only about 40% of the data are digitalized for the lowest system level. The data quality and availability is strongly correlated with the level of digitalization (as evaluated by the network owners). See the example in Figure 3.

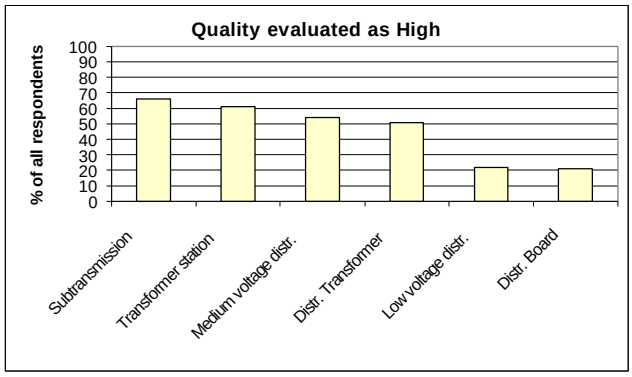

Fig. 3. Percentage of all respondents with quality evaluated as 'High' as a function of system level.

The status among Norwegian utilities concerning computer tools confirmed by the survey, is in many ways a result of the historical development in this area. Whenever a new tool for solving a specific task was available, this was often implemented in the company, without being integrated with the already existing tools. This seems to have been satisfactory in the existing situation, however, with a certain amount of multiple saving of data, high degree of manual work etc.

4 INFORMATION MODELS – COMPENSATION FOR ENERGY NOT SUPPLIED (CENS)

A detailed description of the different tasks and data involved will be an important basis for effective utilization of and information exchange between the various information systems. These kinds of descriptions are denoted information models in the R&D project. The model is part of an information hierarchy starting with the task and ending with the detailed data models at the bottom. This is shown in Figure 4.

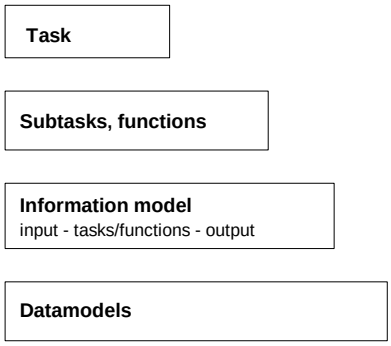

Fig. 4 Task based information hierachy.

The project has made priority to establish information models for the tasks 'compensation arrangement for energy not supplied (CENS)' and for 'planning/design'. The model for CENS is outlined in the following.

From year 2000 the Norwegian network owners will be obliged to pay a financial compensation to their customers for power supply interruptions ('CENS'). CENS is introduced to counteract the possibilities of gradually declining reliability due to increased focus on cost-effectiveness.

The compensation will be based at first on energy not supplied at the distribution transformer level, together with average interruption costs. In its final form the compensation will be based on the interruptions and costs per interruption for each individual customer.

Few of the electricity utilities have information of which of their customers are affected by interruptions. This is due to the lack of possibilities for information exchange between the different systems containing customer data (CIS), network data (NIS), failure and interruption data (FASIT) and data from SCADA systems.

To be able to handle the compensation arrangement in its 'final' form, the network owners need an automatic information exchange between these systems as well as with the customers' meter. The information model is roughly illustrated in Figure 5 showing the main functions and data input to the task.

The different functions that are included in the task 'CENS', are performed using the standardized Norwegian system FASIT for registration of fault and interruptions [3], [4]. These functions and the data model are described in detail in the FASIT documentation. The total process of 'CENS' involves interplay between systems like CIS, NIS,

FIS (fault- and interruption statistics like FASIT) and SCADA. The output is the total amount of compensation to be paid to the customers. The compensation will be returned to the customers as part of the T&D tariffs. This is not shown in the figure.

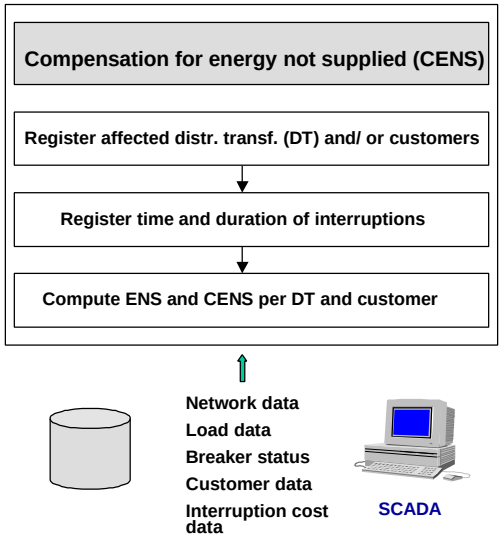

Fig. 5 Information model for CENS (simplified).

5 COST-BENEFIT ANALYSES

In general the network owners have so far achieved too little profitability from their investments in different information systems for planning, operation and maintenance (NIS, GIS etc). This is partly due to lack of functionality or relevant methods and data, and partly that there has been too little focus on effective implementation and use of different tools. The project will therefore contribute to the development of methods and facilities to help the network owners make optimal choices for purchasing, implementation, organization and use of the systems. Such facilities can for example be simple spreadsheet models for cost-benefit analysis. The main challenge in developing such models is to describe the relevant costs and to find simple ways to quantify the benefits concerning the utilization of different information systems (IS).

Potential costs and benefits associated with the introduction of IS in different tasks, are illustrated by including results from a cost-benefit analysis. The analysis is performed at BKK Distribution, which is one of the largest utilities in Norway. Some facts about BKK Distribution is listed in the following:

No of customers:	130000
No of employees	430
Total length of MV system:	3000 km
Total length of LV system:	7000 km
Total value of the network:	4 billion NOK[1]
Annual revenue:	600 MNOK
Annual investments:	100 MNOK

The cost benefit analysis was performed in 1996 and it was revised and updated in 1998. The basis for the analysis was the existing situation of using manual archives and map drawings. At the same time there was a lack of relevant data and user-friendly computation tools. The data had low quality and were multiply stored.

The company had started a process of establishing the necessary data for planning, operation and maintenance and wanted to determine the potential benefits of utilization of network information systems (NIS) for the different tasks. From 1996 till 1998 there has been a process of both reorganization and data collection at BKK, increasing the potentials of achieving effective use of NIS and resulting in higher estimated benefits than in 1996. In this context NIS covers all aspects of data and functionality for planning, operation and maintenance, except for customer data (CIS). This means that geographical network data and fault and interruption data are integrated in NIS.

The costs and benefits are estimated for the period 1999 – 2008. The costs of introducing NIS within BKK Distribution are mainly associated with the collection and digitalization of data as well as purchasing, operation and maintenance of hardware and software. For instance the total costs for 2003 sum up to 6,2 MNOK. More than 50 % of this is connected to establishing the data basis. For the ten-year period a total number of 50-80 man-labour years are needed for the data collection and digitalization.

The types of benefits and their estimated values for the year 2003 are summarized in Table 1.

Table 1 Benefits of introducing NIS at BKK Distribution.

Type of benefit (approx. % cost reduction)	Estimated value in 2003 (MNOK)
Elimination of investments and reinvestments (10 %)	8,3
More proper decisions (10 %)	8,0
Efficient planning/design (40 %)	2,0
Efficient contracting (10 %)	3,2
Efficient operation (10 – 50 %)	7,4
Reduction of network losses (10 %)	2,7
Efficient management (20 – 50 %)	11,7
Sum	43,3

[1] 1 Euro ≈ 8 NOK

The benefits sum up to more than 43 MNOK for year 2003. The annual costs and benefits are shown in Figure 6. The costs decrease while the benefits increase during the period. As can be seen from the figure, a positive net gain (NG) can be achieved each year. The annual NGs are discounted, resulting in a total present value of 200 MNOK for the ten-year period. Thus, the NIS-project at BKK Distribution is found to be highly profitable.

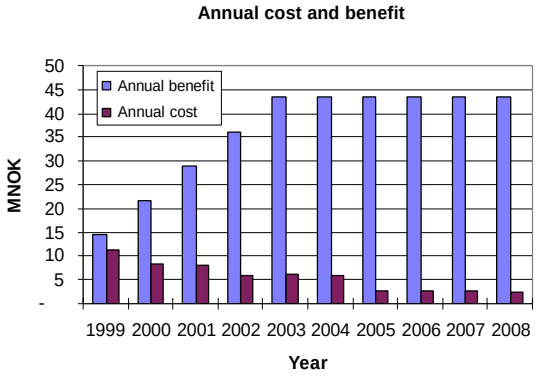

Fig. 6 Annual costs and benefits of introducing NIS at BKK Distribution.

6 DISCUSSION AND CONCLUSIONS

This paper addresses the problem of cost-effective utilization of computer tools for planning, operation and maintenance. Results from a survey among the Norwegian electricity utilities show that the companies to a great extent use function-specific tools. There are various tools for solving different tasks. These tools are usually not integrated and they hardly communicate with each other. In addition it is shown that only about 40 – 60 % of the data are digitalized, depending on the system level. The data quality and availability is strongly correlated with the level of digitalization (as evaluated by the network owners).

This situation has probably been satisfactory up to now, however with a certain amount of multiple saving of data, high degree of manual work etc. In recent years the need for integration/interaction between different computer tools has increased according to increasing requirements for documentation and cost-effectiveness, increasing amounts of data to be handled etc. In particular lack of data and lack of interplay between the different information systems may be a problem when the compensation arrangement is put into force in year 2000. To be able to meet the new regulations with a reasonable consumption of resources, this claims for a more overall planning of the use of computer tools than earlier.

These problems are addressed in an ongoing R&D project that will contribute to establish the basis for more effective and optimal use of the various computer tools. The project will provide common data basis, descriptions of functions and data involved in different tasks (information models) and models for cost-benefit analyses.

Optimal use of computer tools depends on an explicit strategy for the company, taking into account the company's demands for functionality and data-flow, today as well as in the future. This will also depend on the size of the company. There may be small companies being highly cost effective even if they continue using simple calculation tools combined with manual archives.

A basic criterium for success in optimizing the use of various computer tools is however that the data involved are well documented and digitalized. To which extent a company should digitalize its data has to be seen in relation to how the company chooses to meet the requirements for the future.

Potentials for increased effectiveness and cost savings by digitalization of data and utilization of NIS are illustrated by the results from the cost-benefit analysis performed at BKK Distribution, one of the largest electricity utilities in Norway. Improvements can for instance be achieved through a better utilization of the existing network (reduced investments), by more proper decisions and more effective planning and operation.

7 REFERENCES

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