FINDING MAINTENANCE PROJECT TO PRIORITY

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ABSTRACT

The ageing of the power system demands a further increasing activity level, and strive for efficiency drive us against more efficient work processes in cooperation with new technology.

The main challenges for network companies are now implementing new technologies and become more efficient in every part of the asset management. The work processes must be optimized and the right projects must be prioritized for reinvestment.

INTRODUCTION

NTE Nett AS is the system operator of a distribution network with more than 82 000 end users. The power system contains more than 13 400 kilometers power lines and cables and about 6 850 distribution transformers. The power systems cover an area of 22 396 square kilometers, or about 6.9 percent of the mainland in Norway.

The average age for components in the power system is increasing, and there is an expectancy of a higher activity in the process of renewing the power system. NTE Nett AS is seeking the optimal strategy for renewing the power system, and this includes also the right priority between different projects.

The problems related to the priority between maintenance projects are the extensive amount of data and parameters describing the components, the manual evaluation system describing the condition of components and the manually key-entry into the information system. To obtain a more uniform evaluation and a manageable information flow, changes were demanded.

THE NEED FOR INCREASED EFFICIENCY

The power system controlled by NTE Nett AS has been in constant development. Figure 1 illustrates the development for the MV grid in Nord-Trøndelag. This figure also illustrates a coming challenge. In the period from 1970 to 2005 there were built in average about 91 km MV power lines per year. In the period from 2006 to 2010 this average drops to 27 km.

The necessary replacement rate for MV power lines will fluctuate, and depends among other on the climate strain. Our learned lesson states that this renewing rate is about thirty to fifty years. If NTE Nett AS shall have one to one replacement rate, a forty year cycle demands replacement of 108 km / year MV lines. A thirty and a fifty year cycle demands respectively 144 and 87 km / year.

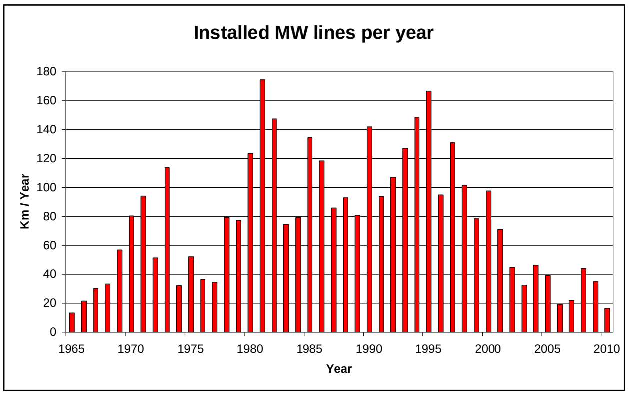

Figure 1 Installed MW lines per year in Nord-Trøndelag

This means that the effort in replacing old lines with new ones has to increase from today's 27 km / year up to about 108 km / year. This is a 400 % increase.

If the replacement rate is not increased, the grid will just be older and older. The failure probability will increase and the risk of severe interruptions in the power grid will increase. This again leads to increased effort in corrective maintenance and fault corrections. More money used in fault corrections and corrective maintenance results in less money for reinvestment. It will become a vicious circle.

The MV network in Nord-Trøndelag can be characterized by having very few costumers per km line/cable or per distribution transformer. The area is wide and sparsely populated. In Nord-Trøndelag there are about 19 customers per km MV line. Figure 2 shows that about 80 % of the distribution transformers in this area supply less than 17 customers.

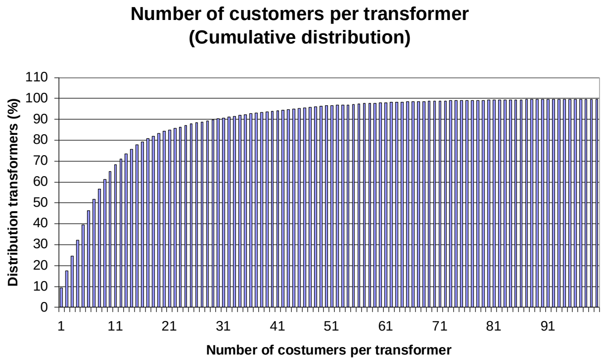

Figure 2 Number of customers per distribution transformer in Nord-Trøndelag

The Norwegian Water Resources and Energy Directorate set an annual income cap for every single network company in Norway. This income cap tells us how much the network company is permitted to earn from the sale of network services. Today's model used to calculate the annual income cap for network companies, does not give incentives good enough to do reinvestments.

In order to increase the replacement rate, the network companies must be able to build more MV lines per Euro. It is also essential to be able to pick out the best projects and prioritize them.

Sufficient information of good uniform quality about the condition of the network is important. New methods and technology to collect and process data can make this process better, more efficient and cost effective.

Smart and efficient methods to evaluate and prioritize different projects may improve efficiency and help the network owner to choose the right projects and implement them at the optimum order.

Smarter, better and more efficient ways to build/replace MV network with new and better equipment may reduce construction costs, the maintenance requirements and the operation costs and thereby also reduce the life time costs for the network.

DATA ACQUSITION

NTE Nett AS does not employ own workers for field related tasks. All requests related to data acquisition are placed as an order at external suppliers. The external suppliers seek the optimum use of their own workforces, and the data acquisitions are performed with a wide variety of workers. Their professional skills related to state estimation will fluctuate. A state estimation performed by a worker will among other depend on experiences, character references and their degree of accuracy in their performances.

To counteract the large variation in the quality of the data acquisition, NTE Nett AS has started a process of improving and simplifying the data set for describing the conditions of components. Simplifying the data was also a request from at the maintenance department in NTE Nett AS. The maintenance department reported an information overflow, due to the vast amount of characters related to power system components. The goal for the improvement and simplification process is to get a more uniform data acquisitions and a more controllable information flow.

The seek for improvement in data acquisition

The data acquisition system depends on personal skills and experience. Taking this dependency into account, there is a need for improvement.

State estimation performed by smart technology can reduce the need for personal skills and local knowledge. These technologies can also make information transmission more efficient. The use of helicopter with power line screening equipment has been used to achieve these goals.

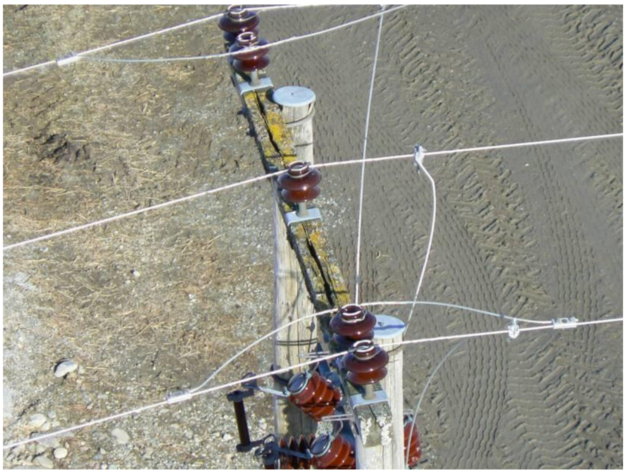

Image 1 Photo taken from helicopter – the cross arm is damaged by rot

Using a helicopter for line-inspections is expensive, but it is much more efficient and time saving than doing it from the ground.

Some inspections can't be done from a helicopter - for example rot control of wood poles. There will still be necessary to do inspections from the ground, but not to the same extent as before. Some years ago data from inspections was only collected by filling out paper forms in the field. The data was afterwards manually entered into computer systems for further processing.

Better systems and handheld computers have now replaced the paper forms and data is filled in directly in computer systems out in the field.

The use of smart technologies and sensors (smart grid) will in the future lead to changes in how distribution networks are managed. Increased monitoring and control will bring new options and solutions in network management. However, the need for manual line inspections will most likely not go away.

PRIORITY PROCESS

After processing the data collected from inspections, the maintenance department picks out the individual needs for improvements and the areas that should be assessed by technical-economic analyses. The individual needs for improvement are ordered directly from an entrepreneur while the technical-economic analyses are performed by own engineers.

The management of assets in electricity distribution networks is very dependent on the priority process. There are several factors that must be individually assessed for each project before an overall assessment can be made in order to give the right projects priority.

Figure 3 illustrates the typical parameters that are assessed today. There are no fixed grading between the different parameters, thus the importance of each parameter will vary from project to project. One of the biggest challenges in this process is to make assumptions regarding the project risks.

The process for finding project priority is controlled by the department responsible for long term distribution system development. The goal of the priority is to find the project that gives a maximum rate of return, taken into account the set of regulation rules stated by the regulator.

Because of the complexity of the assessment parameters and the fact that they have to be graded differently from one project to another, it's not easy to find a general method to evaluate and prioritize different projects. It seems to be necessary to use human power for this process also in the future.

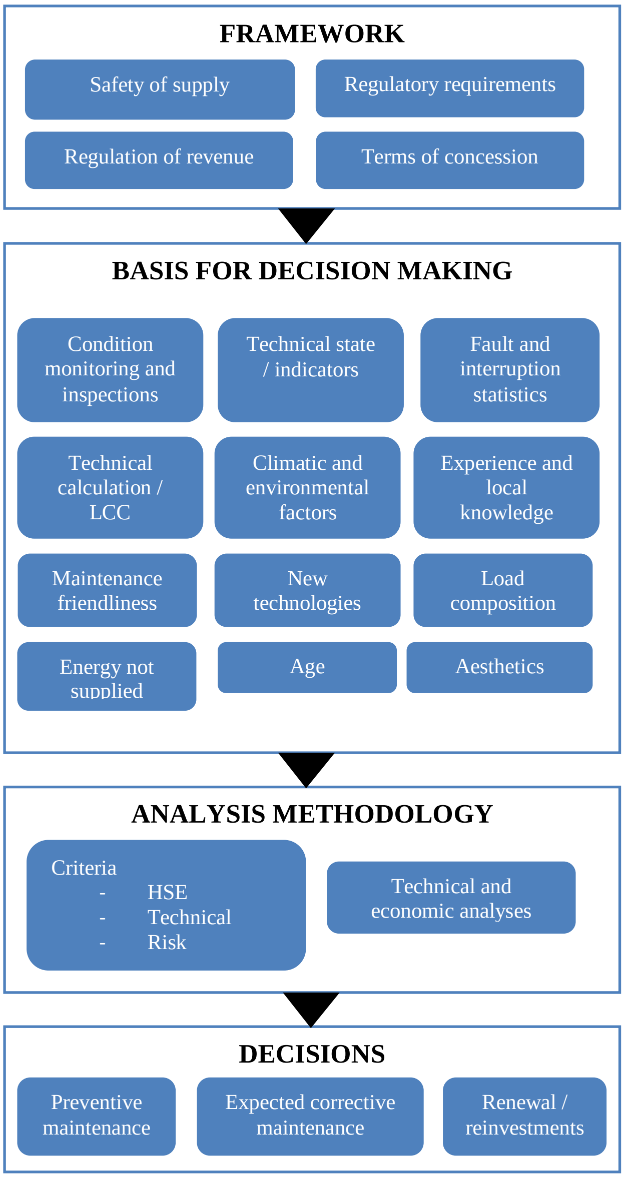

Figure 3 Assessment parameters [1]

SMART GRID – THE DISTRIBUTION NETWORK FOR THE FUTURE

Smart grid has gained worldwide attention for the last few years. There are many visions about smart grid, but there is still need to find practical road maps for how to implement smart grids functionality and data in distribution system asset management – and also when not to implement it.

One main driver for applying Smart grids technologies is the desire to ensure a secure power supply through increasing system reliability.

The future will provide us smarter, better and more efficient ways to build/replace MV network. New and better equipment will reduce construction costs, the maintenance requirements and the operation costs and thereby also reduce the life time costs for the network.

Smarter and better ways to distribute electric power to the consumers can in the future reduce operating costs, give better control of the power flow and thereby give extended life to parts of the network.

The main challenges for network companies are now implementing new technologies and become more efficient in every part of the asset management. The working processes must be optimized and the right projects must be prioritized for reinvestment.

NTE Nett AS in partnership with The Norwegian Smartgrid Centre is about to establish *Smartgrid pilot Steinkjer*. This will be a demo project located in the outskirts of Steinkjer city in the middle of Norway.

The main scope in this project is to gain knowledge and practical experience by using smartgrid technologies to operate the energy system more effectively regarding

- Economy
- System reliability (access to effect and energy)
- Quality of delivery (interruptions and voltage)
- Occupational health and safety
- Environment, esthetics

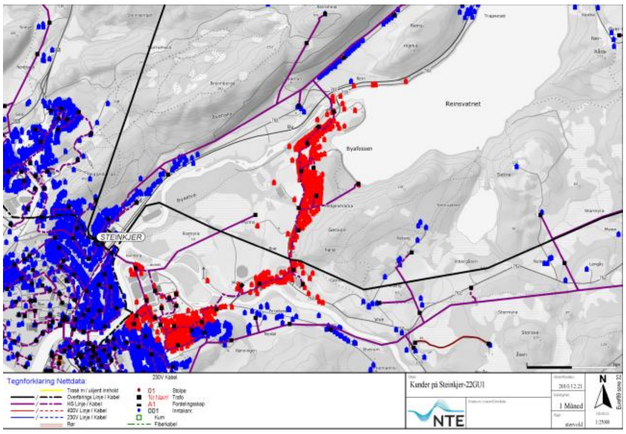

Figure 4 Smartgrid pilot Steinkjer location

The red dots in Figure 4 represent end-users connected to the distribution network included in the project.

Table 1 The scope of Smartgrid pilot Steinkjer

Consumer groups	Number	kWh/year
Households	700	11 140 000
Holiday homes (cottages)	1	7 000
Farms (agriculture)	1	73 900
Small businesses	50	1 250 000
Larger businesses	16	7 629 200
Interruptible consumption	3	1 250 000
Hydro power plants	1	
Total	**772**	**21 350 100**

In this project advanced metering systems (AMS) will be placed in the interface between the network and every consumer (772), and also in every distribution transformer substation (30).

Activities at the consumers:

- Measure consumed energy (kWh/h)
- Wireless display with indication of actual load (kW) and price (NOK/kWh)
- Remote load control (ex. hot water heaters)
- Earth fault registration
- Interruption registration
- Hour priced energy consumption
- Distribution tariffs based on distributed power (kW)

Activities at the substations:

- Measure energy and power
- Earth fault – rules for location
- Short circuit information
- Monitoring and control of switches
- State indicators (open door, temperature, fuses and etc).

REFERENCES

[1] B. I .Langdal, T. Pynten. ”Utilization of grid condition data for efficient maintenance planning”, *Cired 2007, Session 5, Paper No 0583, Vienna, Austria*