INTRODUCTION

The Swedish electricity network comprises three levels: the national transmission grid, regional and local distribution. The national grid (400–220 kV), owned by Svenska Kraftnät, is about 15,000 km long. Three companies mostly own the 31,000 km-long regional network (130–40 kV). The local network is owned by 180 network operators serving 6,500 high-voltage (10–130 kV) and 5.2 million low-voltage (400/230 V) customers. The local medium-voltage (10-20 kV) network comprises just over 120,000 km of overhead line and just over 63,000 km of underground cable. The low-voltage network has just over 100,000 km of overhead line and just less than 200,000 km of underground cable.

BACKGROUND

After some severe disturbances in the MV (Medium-Voltage) rural distribution network caused by storms and wet snow 1999-2001 there were a lot of criticism from customers and society. It was clear that the customers had been more dependent of electricity and did not accept power interruptions as before. This forced the government to make a study of the quality of supply in the distribution system.

DISCUSSIONS

The government study recommended actions to increase the reliability and also suggested legislation and rules for common financing of investments. The Swedish electricity sector’s professional organisation, Swedenergy together with the network companies did not agree with the suggestions in the study and presented an alternative solution based on a number of measures.

After discussions between the government this resulted in a voluntary commitment consisting of six measures instead of new regulations.

THE AGREEMENT

The decided measures are:

- rebuilding of MV overhead lines in forest areas and more/better clearing of line corridors
- an improved organisation for co-operation between companies at severe disturbances
- better routines for information to customers and media
- all customers without electricity more than 24 hours will be compensated with a goodwill discount
- an improved co-operation with the Federation of Swedish Farmers, LRF
- development of a new common statistics over power interruptions

PRESENT WORK

Rebuilding of MV overhead lines

The most vulnerable part of the MV network is the approx. 57,000 km of uninsulated overhead lines in forest areas which causes over 1/3 of the disturbances.

The traditional way of constructing the MV networks in rural areas has been with uninsulated overhead lines. The corridors through forest areas are 10 m wide and falling trees and branches can cause damage to the line. The LV network is mostly insulated with overhead or ground cable.

In order to meet the customers requirements the network companies both improves the clearing of line corridors and rebuilds the lines to new technique.

Traditionally line corridors have been cleared with an interval of 7-8 years but the experiences from recent years have shown that the forests have grown faster so that interval is now too long. The interval is now shortened to 4 years.

The reinvestment time in the networks is normally 35 years but the companies is now making an enormous effort to rebuild the networks in the affected areas in a much shorter time. The initial plan was to rebuild the affected 57,000 km within 20 years but some of the companies with a great amount of rural networks plans to do the investments within 10 years.
Two different techniques are mainly used for the rebuilding:
- Ploughed XLPE ground cable where it is possible due to the ground conditions.
- Covered conductors (BLL or BLX) in existing poles.

**Disturbance organisation**

During major disturbances there is a need for the affected network companies to get help with more resources for the restoration of the network. In order to make the interchange of resources a special disturbance organisation has been set up in Sweden. The country has been divided into seven power co-operation areas. These areas are chosen so that the same storm or heavy snowfall statistically not will affect all the area.

A web-site, [www.elsamverkan.se](http://www.elsamverkan.se) (in swedish only) plays a central part and from here all members have access to “Susie” which is the common system for interchange of information and resources.

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**Information to customers and media**

*Lack of information is worse than the lack of power supply!*

What has happened? When does the power supply return? The one who is alone in the darkness and isolated from the surrounding world, must get quick and accurate information. For that reason the network companies have made a big effort to prepare for an effective information service during power outages.

In collaboration with the Swedish Broadcasting Corporation (Sveriges Radio) a system for handling of information about outages has been developed. Through this system a standardised e-mail about the outage is generated and sent directly to the local public radio station. The system, called “OJJE” is also used for other types of important public information e.g. about traffic, water supply and telecom.

**Goodwill discount**

The target is that a customer shall be out of electricity not longer than 24 hours. But when the conditions are hard and customers are affected by longer outages they shall be compensated.

A goodwill discount is paid to all affected customers. The amount varies a bit between the companies. The size of the discount varies between the companies (see fig. 3), some pays a fixed amount after 24 hours which is increased every 24 hours up to max. 2 years of the total network fee and others pays a percentage of the fixed yearly network fee (NF). Any damages caused by the outage are of coarse also paid for as before.

<table>
<thead>
<tr>
<th>Company</th>
<th>&gt; 24 h</th>
<th>&gt; 48 h</th>
<th>&gt; 72 h</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>SEK 1000</td>
<td>SEK 3000</td>
<td>SEK 6000</td>
</tr>
<tr>
<td>B</td>
<td>25% of NF</td>
<td>50% of NF</td>
<td>100% av NF</td>
</tr>
<tr>
<td>C</td>
<td>SEK 500</td>
<td>SEK 1000</td>
<td>SEK 1500</td>
</tr>
</tbody>
</table>

**Co-operation with the Federation of Swedish Farmers, LRF**

*No one knows the terrain better than the owner!*

In many areas the network companies gets help from local groups, mainly organised in co-operation with the Federation of Swedish Farmers, LRF. These groups, with e.g. their knowledge about the terrain can assist the companies own personnel by patrolling the lines and clearing the corridors from fallen trees and branches when damaged lines are restored after a storm or heavy snowfall.

**New common interruption statistics**

There are two different interruption statistics in Sweden:
One is compulsory for all network companies and operated by the Swedish Energy Agency. It includes the average frequency (SAIFI) and average duration time (SAIDI) for both planned and unplanned interruptions over 3 minutes. The data is on customer level, so the low voltage interruptions are also included.

The second is voluntary and operated by Swedenergy, the branch organisation of Swedish electricity industry. It is called DARWin and includes detailed information about each interruption. It has been under development under a number of years and the coverage of the statistics is now quite good, about 70% of the customers in 2003, and the goal for 2004 is 90%. Most companies use tools for registration within their different Network Information Systems (NIS). The format for the registration and interchange of data is specified by DARWin which is the system used by Swedenergy. Small network companies can do the registration manually in Excel. An annual report with a summary of the results is presented. Figure 4 shows some results from 2003.

<table>
<thead>
<tr>
<th>2003</th>
<th>SAIFI</th>
<th>SAIDI</th>
<th>CAIDI</th>
<th>ASAI</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 kV</td>
<td>0,2299</td>
<td>25,1548</td>
<td>109,4163</td>
<td>0,999952</td>
</tr>
<tr>
<td>12 kV</td>
<td>0,6154</td>
<td>93,2390</td>
<td>151,5032</td>
<td>0,999823</td>
</tr>
<tr>
<td>&lt;10 kV</td>
<td>0,0084</td>
<td>0,7309</td>
<td>87,2674</td>
<td>0,999999</td>
</tr>
<tr>
<td>0,4 kV</td>
<td>0,0381</td>
<td>5,4388</td>
<td>142,7293</td>
<td>0,999990</td>
</tr>
<tr>
<td>Total</td>
<td>0,8918</td>
<td>124,5636</td>
<td>139,6717</td>
<td>0,999763</td>
</tr>
</tbody>
</table>

Figure 4 Unplanned outages >3 minutes in own network

SAIFI System Average Interruption Frequency Index
SAIDI System Average Interruption Duration Index
CAIDI Customer Average Interruption Duration Index
ASAI Average Service Availability Index

**EVALUATION**

The Swedish Energy Agency has been instructed by the government to follow up that the measures in the agreement are fulfilled annually. The follow-up for 2003 showed that:

- 3,000 kilometres of overhead line were insulated in 2003.
- At a steady pace it will take 17 years until all overhead lines in forest areas are insulated. However, in spring 2004 Swedenergy, the industry organisation, gave notice of a doubling of the rate of insulation.
- Communication between power network areas has improved in the last few years. Areas affected by power outages have become better at working together to improve the restoring work.
- When the power fails, information for electricity users has become better thanks to the Internet, SMS services and information via public radio.
- The network companies have undertaken to make financial compensation to customers affected by power outages for more than 24 hours.

**SUMMARY**

After discussions between the Government and the Swedish electricity sector’s professional organisation, Swedenergy together with the network companies a voluntary agreement consisting of six measures were decided instead of new regulations.

The decided measures are:

- rebuilding of MV overhead lines in forest areas and more/better clearing of line corridors
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