THE POWER OF SIMPLICITY

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ABSTRACT

The reliability of Nuon 's electricity grid is for an important extent determined by the quality of the medium voltage (MV) grids. Simple solutions can make a great improvement in the quality of these grids at comparative low costs.

Solutions to improve the quality are not only found in the primary system. An important contribution can also be delivered by the modern control and protection (C&P) installation and the information support to, for instance, grid operators and asset managers. It's a total philosophy. Since a few years Nuon is working with the slogan 'sense and simplicity' to improve the quality of the MV grids. Sense and simplicity means: everything what is not there doesn't fail, costs no money and needs no service. The most reliable component is the component which is not installed.

INTRODUCTION

A Nuon goal is that the average low voltage customer has maximal 20 minutes per year loss of electrical power supply. To reach this goal Nuon has to improve the quality of the delivery. Only 25% of the minutes per year loss of electrical power supply is caused by the high voltage and low voltage grid. The other 75% are caused by the MV grid. In the MV grid 82% of the interruptions are caused by faults in cables and cable joints. Digging and component failures are the main causes. The average recovery time for a fault in a MV cable or MV cable joint is around 90 minutes.

The yearly interruption time can be very effective reduced with a cable and pipe information centre (KLIC [1] is an example for such a centre). Reliable MV cable and MV cable joints and low stress levels help to prevent faults. The MV cable and cable joint can be stressed by high loads and over voltages. If there is a failure, fast trip times for high fault currents and soft (non effective) earthing prevent future failures. Fast automatic fault location can reduce the average recovery time for a fault in a MV cable or MV cable joint from 90 to 60 minutes.

PRIMARY SYSTEM

Some actions Nuon applied to improve the primary system are structured replacement of nekaldiet joints, introduction of Cross Linked Polyethylene (XLPE) cables and the implementation of soft earthing.

Nekaldiet joints are a weak link in the MV grid. Figure 1 gives an example of a weak nekaldiet joint. Since 2002 Nuon is working on a program to find and replace the weakest nekaldiet joints. From 2002 till August 2006, 17% of the nekaldiet joints have been replaced.

Figure 1: Cross section of a weak nekaldiet joint

Paper Insulated Lead Covered (PILC) cable has a long life time if it is loaded below 70% of the nominal current. At higher currents PILC is less reliable. With the introduction of XLPE cable in 1996 the quality of the MV connections is improved. The XLPE cable has a higher current carrying capability than PILC cable. Short time (severe hours) of overloading has hardly any influence on the lifetime of the cable. To prevent over voltages the XLPE cable must be protected by surge arresters. This is the insurance contribution for a reliable XLPE cable connection.

Soft earthing of the MV grid is introduced in 2005. The isolated grids are earthed with an earthing transformer to inject a current with a maximum of 2 kA, if there is a single phase to earth fault. With this current injection the protection can detect and trip the single phase to earth fault. Besides that the automated fault location system can locate more accurate the single phase fault [2]. Moreover soft earthing protects the grid in failure situations against high step- and over voltages to earth. This prevents chain reactions and open fires in transformers and cable joints. Studies show that soft earthing will not cause problems for the LV customers [3] [4].

CONTROL AND PROTECTION

The coming years Nuon has to refurbish the C&P installation of more than two hundred MV installations in substations [5] [6] [7]. This has to be done for reasonable prices, with sense and simplicity.

The SASensor system (figure 2) is an innovative total solution for C&P. For a MV installation in a substation all C&P functionality like measurement (U, I, P, Q), kWh metering of class 0.2s, power quality measurement, protection, control and fault location is accommodated in

two redundant computers. There are three types of I/O modules, CIM (current interface module, figure 3), VIM (voltage interface module) and BIM (breaker interface module). The I/O modules are placed in the MV bay and communicate over glass fibers with the central computers. With this system the amount of equipment and cabling can be reduced enormous. This saves time and costs.

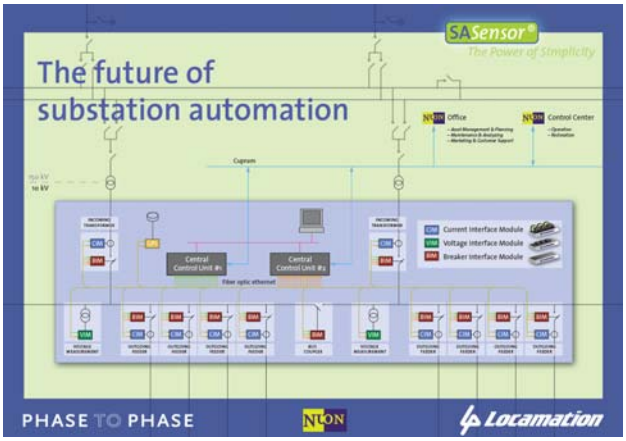

Figure 2: SASensor system

EMC is much more in control by the use of glass fibre. Furthermore the cabling of the SASensor system is quite simple. This will cause less human errors and a higher availability. Support from the SASensor system during commission, self test and function recovery (in the case an I/O module has failed) will also raise the availability of the system. The estimated life time of the I/O modules is equal to the life time of the primary installation. Therefore only the central computers have to be renewed with a later renovation of the SASensor system. This saves time and costs again.

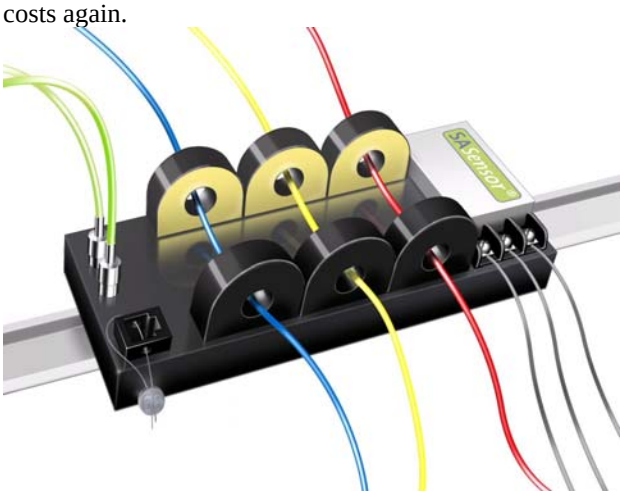

Figure 3: Current Interface Module

The development of the SASensor system started in 2004. In 2006 it was implemented in three substations with CIM, VIM and functionality for measurements (U, I, P and Q), power quality measurement and fault location. In 2007 it will be implemented in ten substations with full functionality. Feedback from the end users to the developers is an important item in the pilot. It helps the developers to make simple and useful solutions which are easy to understand for the users.

The next step is to bring a low cost SASensor solution, with the same profits, in combination with Magnefix in the MV houses, see figure 5. This development is started in 2006. This solution makes it possible to implement full C&P functionality on a lower level in the network at acceptable costs. This new product is a cost effective solution for both new installations and renewal of existing installations. To realize measurements, low cost current transformers and cable connected voltage transformers are installed on the Magnefix. With a BIM it is possible to control the circuit breakers of the Magnefix. The final product is expected at the end of 2007.

INFORMATION SUPPORT

SASensor gives more functionality without installing extra equipment. Examples are power quality measurement, fault location, teleservice and information support to the office, see figure 4. To make this possible a lot of attention is paid to cyber security in and around the SASensor system.

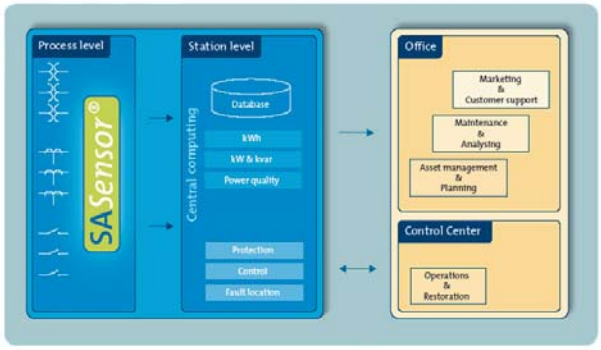

Figure 4: C&P with SASensor and information support

Power quality measurement makes the quality of the energy supply visible. The information is used for reporting to the regulator. It makes it also possible for Nuon to take action to prevent power quality problems for the customer.

For fault location [2], information about voltage, current and switch positions during the fault is given to a computer in the control centre. With this information the computer calculates the possible fault locations. The software is based on the Vision software package of Phase to Phase. The application acts like a reverse short circuit calculation. In other words the currents and voltages are known, calculate the possible fault locations. The software checks the fault clearing time with the settings of the protection to reduce the number of possible fault locations.

Other methods for fault location are information from short circuit indicators which is send over the mobile network and

postal code information from incoming telephone calls after the black out. The last method is getting less helpful due to recent developments, like voice over IP. The combination of the results from the three methods can give an accurate fault location. With this information the operator in the control centre can send the fault clearing team direct to the place concerned. For a fault in a MV cable it will save 30 minutes in the average recovery time.

Figure 5: Magnefix with short circuit indicators, current transformers and mobile network connection

If there are problems in the SASensor equipment, tele-service facilities make it possible to solve many of the problems. In this way the deployment of a good skilled service team is much more efficient. With more information in the office it is easier to make good decisions for marketing, customer support, maintenance, analyzing, asset management and planning. These applications will be developed in cooperation with the users.

The SASensor system gives a more reliable energy supply and a visible quality of the energy supply. It makes it possible to do 'just in time' investments and more efficient deployment of a service team. The trick is to make information from data. This makes it possible to do good things in a good way. The power of simplicity.

CONCLUSION

Solutions to improve the quality of the electricity supply can be found in the primary system, C&P installation and the information support to the office and control centre. The solutions described in this paper are mainly related to the MV grid because here the most profit can be gained.

Examples which are used in practice are the replacement of nekaldiet joints, introduction of XLPE cable, soft earthing, automated fault location, fast trip times, introduction of SASensor systems in substations and MV houses and development of office and control centre applications. For all these solutions 'sense and simplicity' is the key to success.

REFERENCES

[1] Homepage for KLIC http://www.klic.nl/english/

[2] P.M. van Oirsouw, F. Provoost, 2003, "Fault location in an medium voltage network", *CIRED 2003.*

[3] F.T.J. van Erp, J.F.G. Rasing, M.J.M. van Riet, F. Provoost, A.P.J. van Deursen, P.L.J. Hesen, 2005, "Modelling and live measurements of step and touch voltages at LV customers in urban areas caused by MV faults", *18 th International Conference on Electricity Distribution, Session: Power Quality and EMC, CIRED 2005*

[4] F.T.J. van Erp, J.F.G. Rasing, M.J.M. van Riet, F. Provoost, A.P.J. van Deursen, P.L.J. Hesen, 2007, "Modelling and live measurements of step and touch voltages at LV customers in developing grids, caused by MV faults", *19 th International Conference on Electricity Distribution, Session: Power Quality and EMC, CIRED 2007*

[5] M.J.M. van Riet, F. L. Baldinger, W.M. van Buijtenen, F.J.T. van Erp, F. Volberda, F. Provoost, 2005 , "Alternative approach for a total integrated secondary installation in MV substations covering all possible and required functions", *CIRED 2005.*

[6] M.J.M. van Riet, F. Provoost, F. van Erp, 2003 , "New features during refurbishment of substations", *CIRED 2003.*

[7] M.J.M. van Riet, F. Provoost, F. van Erp, 2004 , "New intelligent features during refurbishment of substations", *IEE symposium on developments in Power Systems Protections 2004.*