

## DETAILED COMPONENT DATA AND CUSTOMER INFORMATION AS A BASIS FOR MORE DETAILED FAULT AND OUTAGE STATISTICS

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### ABSTRACT

*The paper present the historical Danish approach for fault and interruption statistics within the ELFAS cooperation. From January 2013 ELFAS have introduced a revised set of guidelines and recommendations on registering detailed component and customer information for detailed fault and outage statistics for future use in asset management and in a more detailed view on continuity of supply.*

### INTRODUCTION

Distribution Network Operators (DNOs) in Denmark have registered component failures and customer interruptions since the late 1960s. The registration has been carried out as the basis for the ELFAS statistics (ELFAS is the abbreviation of “El-selskabernes Fejl- og Afbrudsstatistik”, the DNOs’ Fault and Outage Statistics). The ELFAS statistic is a voluntary cooperation on registering grid disturbances, component failures and customer interruptions.

In the early years the ELFAS statistic was focused on transmission networks, transmission network components and outages and outage duration of system units (transformer, lines etc.). Since the year 1974 the ELFAS statistic also has included distribution network components and distribution delivery points, and since 2007 the low voltage networks have also been included due to legislation set up by the Danish Energy Regulatory Authority as basis for the national Regulator’s benchmarking and regulation of Continuity of Supply. Since 2006, the number of customer interruptions has also been registered and yearly customer interruption indexes have been calculated as a part of the ELFAS statistics.

In December 31<sup>st</sup> 2012 the ELFAS statistics represented approx. 95 % of the distribution network and 95 % of the total number of customers in Denmark. The total number of customer in December 31<sup>st</sup> 2012 was approx. 3.285.000 customers.

In the light of more DNOs introducing a higher level of asset management the ELFAS statistic has been meet by higher demands for more reliable and more detailed fault and interruption statistics. As a consequence of this, a revised version of the ELFAS statistics’ guideline is found necessary.

The latest version of the guideline was revised in October 2003.

### ELFAS STATISTICS – THE SIMPLIFIED HISTORICAL APPROACH

Until 2012 the ELFAS statistic has had a more general approach to the estimation of component’s failure probability and to the calculation of interruption indexes.

#### Component failure probability

All companies in the ELFAS statistic have registered component failures when a component is faulted. Each component failure has been classified and grouped according to which component type group (e.g. cables, overhead lines, circuit breakers, switch disconnectors, transformers etc.) the faulted component is classified within. From these data, the sum of component failures within each component type group has been calculated for all companies within each year. Further, all companies registered the sum of components with each component type group. From these two numbers the estimated component type group failure probability was calculated for each component type group by:

*Component failure probability per year =*

$$\frac{\sum_{i=0}^n \text{Sum of component failures in company } i}{\sum_{i=0}^n \text{Sum of components in company } i}$$

This estimated component failure probability approach leads to a generalized failure probability which takes no detailed component information into account beside the component type. In some cases, e.g. for cables, a higher level of components information is taken into account (XLPE-cables or oil-filled cables).

#### **Detailed information on component failures**

Until now (December 2012) all DNOs have been asked to register detailed information on each component failure beside the type of faulted component (e.g. cable, transformer, circuit breaker etc.) to the ELFAS statistics. This detailed information covers e.g. age of faulted component, type and manufacture of faulted component, component properties like cable cross section, transformer type (e.g. oil or dry type) etc. The companies’ ability to

register these detailed information have been varying. Some companies have been able to look into e.g. other network databases including detailed component information. Other companies have no network databases and as a consequence of this, these companies must rely their registration on information from personal inspection of a faulted component. In many cases detailed component information has been left out.

### **Interruption indexes**

The calculation of interruption indexes, SAIFI and SAIDI have been calculated according to international standards [2]:

*System Average Interruption Frequency Index (SAIFI) =*

$$\frac{\sum_{i=0}^n \text{Sum of customer interruptions in company } i}{\sum_{i=0}^n \text{Sum of customers in company } i}$$

*System Average Interruption Duration Index (SAIDI) =*

$$\frac{\sum_{i=0}^n \text{Sum of customer interruption minutes in company } i}{\sum_{i=0}^n \text{Sum of customers in company } i}$$

All customer interruptions (and durations) are summed as an aggregated value per delivery point (i.e. number of customers per 10/0.4 kV transformer).

### **Detailed information on customer interruptions**

Since 2006 the interruption indexes have been calculated for consumers as well as for producers. Further, customer interruptions are categorized according to five types of outages defined by the Danish Energy Regulatory Authority:

- Unplanned,
- Planned,
- Third party influence,
- Force majeure/extreme weather and
- "No supply from transmission network".

As the basis for the interruption indexes each company report the total number of customers for each customer connection type. All companies are asked to report the number of customers per customer connection type. The customer connection type defines where and on which voltage level the customers are connected to the network (customer type A, B or C, where connection type A represents customers connected at 30-60 kV level and connection type C represents customers connected within the low voltage network).

### **A NEED FOR MORE DETAILED FAULT AND OUTAGE STATISTICS**

During discussions between Danish DNOs in 2011 and 2012 more DNOs asked for more detailed component information on the expected component life times for better asset management in distribution networks e.g. the life time of cables, transformers circuit breakers etc.

Further, more DNOs also asked for more detailed information on outage statistics related to customer densities (high/urban, medium/suburban, low/countryside, minor islands) and customer categories (households, industry, farming and agriculture, shopping and offices, others).

### **Available component and customer data**

During the DNOs discussions, an analysis was carried out checking which detailed component and customer data which actually was available in the DNOs' component and customer databases ready for data exchange to the ELFAS database.

The data analysis showed that not all detailed component information was available for all component types in all companies e.g. age of cables. However, most companies had a very high level of detailed customer data.

### **RECOMMENDATIONS ON COMPONENT AND CUSTOMER DATA**

As a result of the component and customer data analysis and the ongoing discussion for Danish DNOs all DNOs in the ELFAS statistics are recommended to register the following information for each component and for each customer in the company's network. From this information a detailed registration of faults and customer interruptions can be done, and a more detailed fault and outage statistics can be carried out:

For (faulted) components:

- Component category
- Date of commissioning (or year of)
- Manufacturer
- Type (component properties)

For (interrupted) customers:

- Customer type (consumer/producer)
- Customer density (high, medium, low, island)
- Connection type (A, B, C)

### **RESULTS AND FUTURE WORK**

Until now (December 2012) only very little results have been shown. However, previously work has shown, that it is

of high importance that the same detailed information for the faulted component and the total number of components, and interrupted customers and the total number of customers respectively.

In 2013 all companies within the ELFAS statistics will be asked to exchange detailed component and customer information, so that these data will be available for the ELFAS statistics.

## REFERENCES

- [1] Danish Energy Association, P. Hansen, 2013, "*Retningslinjer for El-selskabernes Fejl- og Afbrudsstatistik (ELFAS)*" (only in Danish)
- [2] Cenelec, CLC/TR 50555, 2010, "*Interruption indexes*"