MAJOR DISTURBANCES – DEVELOPMENT OF PREPAREDNESS IN FINLAND DURING THE LAST DECADE

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ABSTRACT

Two major disturbances in the supply of electricity have shown the vulnerability of distribution system and modern society's dependency on the continuous supply of electricity in Finland during the time period of 2001-2010. During this period many measures to improve the situation have been done by different actors of the Finnish society. In this paper, the main focus is on the preparedness of distribution system operators.

It could be stated that actions taken have improved the preparedness of DSOs and other actors but still there is lots of development needed in this field.

INTRODUCTION

In November 2001, two autumnal storms caused a series of wide and long-lasting interruptions in the supply of electricity in Finland widely disturbing the operation of society [1; 2]. Because of these events modern society's great and all the time increasing dependency on the electricity was realized in Finland. In addition, the lack of sufficient preparedness of distribution system operators (DSO) as well as customers was recognized.

Nine years later i.e. in 2010, four summer storms left hundreds of thousands customers without electricity in Finland, for a month in the worst cases. Basically, the societal consequences were similar as nine years earlier.

In this paper, a comparison between major disturbances occurred in 2001 and 2010 is presented. The paper presents the troubles experienced in 2001, efforts to improve the situation after those storms and experiences from the storms in 2010. Thus the main problem of this study is: Was the society somehow better prepared for storms and long-lasting outages than nine years earlier? The main focus is on DSOs. Some examples from two winter storms occurred in Sweden in 2005 and 2007 [3; 4] are also presented.

The main source of information of this study is the reports about these occasions. However, there was not available any official reports concerning the 2010 storms when writing this paper, and thus information published by DSOs and the media via internet during the events must have been utilized. As a source of information is also used a questionnaire study (for the Finnish DSOs) executed in an ongoing research project in Tampere. The topic of the project is developing the management of major disturbances in the supply of electricity. The questionnaire study focused on the current state of management of major disturbances and it was carried out in spring 2010, i.e. before the 2010 storms. The response rate was 60 per cent (52 out of 86 DSOs).

EARLIER STORMS AND CONSEQUENCES

Storms in November 2001

Two storms named Pyry and Janika brought heavy snow loads in November 2001 causing about 90,000 trees to fall on the lines. This resulted in over 30,000 faults in the low and medium voltage networks affecting over 860,000 customers around southern Finland. Interruptions lasting longer than five days affected over 1,600 households. The network repair costs of the two storms amounted to over 10 million euros. [5] The forest damages exceeded 7 Mm^3 of fallen trees [6].

The most significant societal consequences caused by the interruptions were communication and cooperation problems between some main operational actors, interruptions in telecommunication networks, troubles in water supply and sewerage, troubles in farms with no reserve power, and lack of information in many cases (e.g. estimations about the duration of the outages). The biggest reason for these troubles seemed to be the lack of preparedness of the most actors. [1]

Two winter storms in Sweden

The societal consequences of the two winter storms – Gudrun and Per – were basically similar in Sweden as in Pyry and Janika. The first and more severe one i.e. Gudrun was experienced in the southern parts of Sweden in January 2005. Due to this also the regional networks were partly destroyed in the same way as distribution system. It has been estimated that 730,000 customers were without electricity during the worst time, some of them for up to 45 days. Restoration costs for DSOs were roughly 240 million euros (2,400 million in Swedish Kronor) and voluntary compensations for customers about 60 million euros. Total amount of compensations paid by insurance companies were roughly 400 million euros. Forest damages were 70 Mm^3. [3; 4]

Two years later, storm Per was experienced in somewhat same areas as Gudrun. The forest damages were 16 Mm^3 of fallen trees and 440,000 customers experienced interruptions. The longest interruptions were approximately 10 days. Restoration costs for DSOs were about 65 million euros and standard compensations paid for customers 75 million euros. Total amount of compensations paid by insurance companies were 55 million euros. [4]

ACTIONS TOWARD BETTER PREPAREDNESS

Legislative reformations

In 2001 the price reductions and compensations that were paid according to the Finnish Electricity Market Act were small and case-specific, and hence considered inadequate for covering the real losses experienced by customers. The status of a customer was improved by reforming the Act in 2003 by so called standard compensation practice. Thus, a customer is entitled to stepwise increasing compensation (10 - 100 % of the annual system service fee but 700 € at the maximum) after interruption lasting 12 hours or longer. [7]
From the beginning of 2006 the Swedish Electricity Act has included the standard compensation practice as well. The basic idea is similar as in Finland but the compensations also have constant minimum values and the maximum value is 300 per cent of the annual network cost. At the same time, the maximum duration of an interruption was stated, and thus an interruption of a customer must not last longer than 24 hours from the beginning of the year 2011. [8]

Tightening of economic regulation

Because DSOs operate as monopolies the operations of those should be regulated. From the beginning of the second regulatory period (2008-2011) the regulation was tightened in Finland by taking also the interruptions into account when calculating the acceptable profit of the DSOs. The value of interruptions is determined with the help of energy weighted reliability indices of networks and in advance defined interruption cost parameters, and this is compared with the calculated reference value. Only half of the difference between actual and reference interruption costs have an effect on the acceptable profit, and the maximum effect can be only 10 per cent of the reasonable return calculated for capital invested after taxes. [9]
In the ongoing regulatory period, in addition to the power quality incentive also an efficiency incentive for each DSO was added. Moreover, the standard compensations are now included in the controllable operating costs, whereas they were earlier treated as pass-through components, and thus did have no effect on the acceptable profit. [9]

Actions among DSOs

The Finnish Electricity Association (nowadays Finnish Energy Industries) published the guidelines for a provision plan against major disturbances in 2002. Among other instructions the importance of cooperation with other actors and crisis communications are emphasized. [10] According to the questionnaire study carried out in this project about 80 per cent of the DSOs have prepared some kind provision plan and it was seen useful although inadequate in many cases.
Some projects in order to improve the cooperation with other actors have been executed. One example is the cooperation organized by the Finnish Forestry Centres against the forest damages. In order to be prepared for storms the Forestry Centres with the representatives of fire and rescue services, forest industry and DSOs have created regional provision plans. [11]
Another good example is this ongoing research project, in which the management of major disturbances has been developed. The management includes cooperation and communications between different actors participating in the recovery operations during the major disturbances. According to the questionnaire, DSOs seemed to have made contracts with some other actors for major disturbances. Major part of respondents has contracts with neighbouring DSOs, network contractors, excavator contractors and local forest workers. Minor part also has contracts with local electricians, transport companies, forest harvester contractors, farmers and forestry societies. Also helicopter company was mentioned by one respondent. Over half of the respondents have carried out training, and about half of these mentioned that they have had training also together with other actors, above all with fire and rescue services.
The lack of the information for customers was seen a big problem during the 2001 storms. After the storms many DSOs have developed their customer communications considerably by utilizing SMS and email services, and real time map-based web service. The questionnaire showed that 72 per cent of the DSOs use internet, 8 per cent SMS or email services, 56 per cent automatic answering machine, 72 per cent (local) radio channels and 78 per cent conventional phone service as communications channels during major disturbances.
It is obvious that one measure for better reliability of electricity supply and against major disturbances is network investments. DSOs have recently invested in underground cabling and network automation among others but quite often these investments aim at better reliability at system level. This may often be an optimal solution from interruption costs perspective but easily leads to a situation where some customers may still experience bad reliability of the supply. In Finland the Finnish Energy Industries together with DSOs has decided to implement new supply reliability criteria as planning criteria into long-term network development. The criteria cover sum of duration of long interruptions and number of short interruptions (< 3 min) experienced by a customer per year. This way the status of a customer could be improved. The criteria are presented in detail in [12].
After Gudrun, some measurements were carried out by the Swedish DSOs. A tree securing programme for the regional networks has been carried out, DSOs have invested more in underground cabling due to new tightening in the Electricity Act, and using of the computerized support system (SUSIE) for cooperation between DSOs has been trained by the personnel. [3; 4]

Other actions

It is commonly seen that it is impossible to achieve perfect reliability of power supply, or at least not economically reasonable. Therefore some preparation for major disturbances is needed also by the customers. In order to improve the preparedness of certain customers some measures have been taken by different authorities: for instance farmers have had a possibility to get financial support for a reserve power supply system and the Finnish Communications Regulatory Authority has set a new regulation [13] that defines the priority rating of the components of the communications networks and the securing of their power supply.

Moreover, the Ministry of Defence of Finland has published a guide about preparation for citizens in 2008 [14]. A more comprehensive guide about long blackouts and their effects on the functions of the society has also been introduced mainly for the use of the authorities. [15]

STORMS IN SUMMER 2010

In 2010 between July 30th and August 8th, i.e. during 10 days, four summer storms named Asta, Veera, Lahja and Sylvi with unusually strong lightning and thunder squalls left over 450,000 customers without electricity in Finland and almost 100,000 of them longer than 12 hours. The total costs for DSOs were over 32 million euros (standard compensations 10 M€, operational costs 18 M€ and investments 4 M€). [16] Forest damages were 8.1 million m^3, and the related compensations paid by the insurance companies were at least 54 million euros [17; 18].

According to information bulletins given by Finnish DSOs after the storms, the longest interruptions experienced in permanent residences in rural areas were up to a month and even longer at holiday houses. Figure 1 illustrates the number of customers (of one DSO) without electricity as a function of time. The graph is formed with the help of bulletins published by this DSO (Savon Voima Verkko Ltd.).

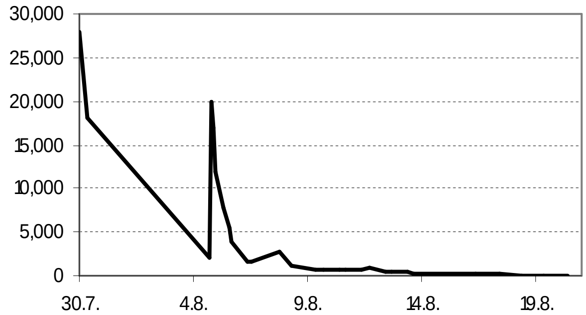

Figure 1. Amount of Savon Voima Verkko's customers without electricity due to storms of 2010 [19].

When comparing the statistics of these storms with storms in 2001 and storms in Sweden it could be said that the level of destruction was somewhat equal as in Gudrun but only in certain small areas. This is because the longest interruption times were similar both in 2010 storms and in Gudrun but the level of operational/restoration costs of DSOs and the forest damages were much higher in Gudrun (and even in Per). Therefore the distribution for the interruption times would be some sort of combination of 2001 storms and Gudrun: most of the customers experienced interruptions lasting hours or a day at the maximum whereas some customers in certain areas lack electricity for up to a month. In [20] is said that the media is often a useful source of information in order to get an idea on the different consequences of electricity blackouts. However media usually dramatizes events and therefore this information should be handled critically. During and after the storms in 2010, the media seemed to follow the bulletins given by DSOs. Also the staff responsible for DSOs' communications was interviewed frequently during the blackouts. Therefore the reportages of the media quite often focused on the numbers rather than highlighting societal consequences caused by the lack of electricity. However, at least interruptions in telecommunications networks and troubles in water supply and sewerage were highlighted several times again.

The consequences of these storms lead to a thorough investigation executed by the Accident Investigation Board of Finland. The series of events, causes and effects will be found out in order to improve the public security and prevent similar accidents in the future. The results of this investigation will be published in 2011. [21]

WHAT IS BETTER NOW THAN BEFORE ?

Based on the material available, it could be said that situation in general was not in 2010 as bad as in 2001. At least customers have been better informed both before the events and also during them. Many DSOs have had good own instructions against blackouts for households or a direct link to the guidebook mentioned above. This together with better customer communications of most DSOs during the blackout gave customers much better basis to manage than nine years earlier. The information given in 2010 (and 2001) was in many cases too optimistic, which is not desirable. Three level of DSOs' customer communications could be found : some delivered information in real time (e.g. map-based web service), some gave daily bulletins and some published information at longer intervals.

In 2001 the troubles in farms, especially in dairy farms and piggeries, get substantial attention in media. In 2010 similar troubles was highlighted few times. Thus it could be concluded that farms are today better prepared than in 2001. One explanation to this is surely the possibility to get financial support for a reserve power system.

There are good examples from the storm Per in Sweden how the preparedness was better than earlier. Because the affected area related to Per was quite same as in Gudrun and it occurred only two years later, the different actors had everything still clear in mind and were able to utilize that time these experiences. Therefore crisis management in general was quicker and better in all as well. [4]

WHAT SHOULD STILL BE DEVELOPED ?

Although many things seem to be better nowadays there are also many things that should still be improved. One big problem still relevant is the long interruptions in the telecommunications networks that get very much attention in media and from authorities. The solving of this situation is however quite problematic because according to public discussions representatives of teleoperators see it is DSOs' responsibility to secure the supply of electricity, and vice versa. The importance of the communications network is so high especially in these kinds of events that solution to this dilemma should be found in the near future.

In this ongoing project, one objective is a prototype of the common operational picture system that would improve the delivery of information between the operational actors. The basis of this system is introduced in [22].

The development toward weather-proof network (underground cabling) should be done more forcefully. Thus more incentives for DSOs are needed. In [23] risk of major disturbances has been considered for the guidelines of the next regulatory period. The "cutter" of 10 per cent when calculating the effect of interruption is seen too low and is suggested to be increased. Also the standard compensations, at least the maximum value, are seen too low.

CONCLUSIONS

Although most of the Finnish DSOs and many other actors were better prepared in 2010 than in 2001 the destruction in the most affected areas came as a surprise to most. Thanks to improvement measures the preparedness level was maybe high enough for cases like Pyry and Janika but far too low for the destruction like in Gudrun.

The incentives given by the Finnish regulation and legislation seem to be to low from major disturbances point of view. When comparing with situation in Sweden analogy between severity of the storms and new reformations after the storms could be seen. For example, standard compensations are much higher in Sweden maybe because the consequences of Gudrun were more severe than in Pyry and Janika. Because the interruptions in the 2010 storms were in some places much longer than in 2001, it could be supposed that some tightening in the regulation and more incentives toward weather-proof network will be seen in the future. The investigation carried out by the Accident Investigation Board of Finland will generate proposals for actions toward the better preparedness of the whole society.

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