

SOCIETIES' REACTIONS TO LARGE DISTURBANCES

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ABSTRACT

This paper addresses the impact of recent large disturbances in the supply of electricity on electricity distribution business. The consequences have shown varied attitudes towards the acceptable level of electricity quality and security of supply. The resulting regulations and amendments to existing legislation have caused economic strain on electricity distribution companies to compensate for damages but have improved the status of an individual customer.

INTRODUCTION

Completely uninterrupted electricity supply is a feature that cannot be required of electricity distribution companies. Electricity distribution networks are prone to weather conditions and unforeseen events, and therefore securing the electricity supply to the fullest is not an economically sensible goal. This is one of the bases when designing networks and their operation; there is a balance between the company's cost of quality-securing measures and the inconvenience caused by an interruption to the customers. This means that customers have to be willing to accept a reasonable level of electricity quality disturbances. On the other hand, the inconvenience of a customer interruption has become real in a sense that the electricity distribution companies face new regulations concerning the quality of electricity supply.

Large disturbances in the past few years have raised public awareness and debate over the acceptable level of continuity of supply and the compensations paid to customers when this acceptable level is not met. The debate not only concerns with large disturbances but the general level of electricity supply. Society has found itself more dependent on electricity supply, and therefore the pressure to assign regulations on the continuity of supply has become evident. Development of this kind will make quality aspects crucial in the operation of electricity networks. The costs of these regulating instruments have been quite substantial to the distribution business, and more regulations are planned in order to achieve and maintain acceptable level of supply. In the next chapters, the large disturbances of the past few years in Finland are discussed and the resulting regulations are introduced. In addition to legislation, the regulations comprise the industry's own regulations. The following chapter discusses the cost of large disturbances, and finally, experiences from other Nordic countries are introduced.

LARGE DISTURBANCES

The recent discussion of the continuity of supply issues in Finland started in 2001 when two winter storms caused severe interruption to the electricity supply. The continuity of electricity supply is generally considered to be of high level, and therefore, the storms aroused wide attention of the media. Figure 1 shows the average interruption time per customer between 1973 and 2005 [1]. The effect of winter storms can clearly be seen from the statistics. Currently, over half of the interruptions are caused by weather and animals [2].

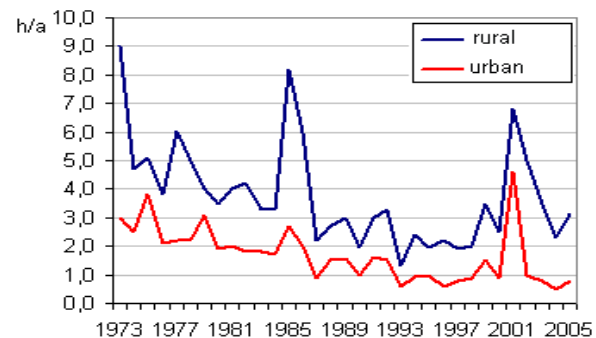


Figure 1. Average interruption time per customer between 1973 and 2005 [1].

A major disturbance is a condition in which more than 20 % of the customers are without electricity, or the 110 kV line, the 110/20 kV primary substation or the primary transformer is out of operation for several hours because of a fault. The two winter storms affected over 800 000 customers and caused about 30 000 faults in low and medium voltage networks. Interruptions of 12–24 hours were experienced by 140 000 customers, while interruptions lasting longer than five days affected 1600 households [3]. The severity of the interruption was increased by the fact that it was winter time, and some customers, particularly farms in rural areas, were dependent on additional power sources. Only about 22 % of the distribution networks in Finland are built with underground cables. Overhead lines are common in sparsely populated rural areas; the trees that fell on the lines during storms also damaged the poles by knocking them down. Consequently, some parts of the network had to be rebuilt. Heavy snow impeded repair works driving the human and technical resources to the extreme limit.

REGULATING LARGE DISTURBANCES

As a result of the large scale storms experienced in 2001 and the growing demands for the continuity of supply in general, different regulations have been introduced. These regulations have been legislative in nature but the industry itself has also been active in compiling guidelines concerning the reliability of the distribution networks. There have also been intentions to introduce quality regulation in the economic regulation of the electricity distribution monopoly in order to guarantee the continuous development of network. Hence, quality issues are emphasised in many ways in the operation of a distribution company.

Society regulations

The Finnish Electricity Market Act (386/1995) obligates electricity distribution companies to maintain, use and develop the network in a way that reasonable demands of the customer are met and electricity supply of sufficient quality is secured [4]. The rationale of the law is that reliability should be at a level generally accepted; however this level is not specified [5]. Neither are the conditions beyond normal operation fully presented. The Electricity Market Act simply states that the electricity supply is faulty if the quality of electricity or the manner by which it is supplied does not correspond to what can be considered to be agreed upon [4]. Further, unless otherwise agreed, electricity supply is faulty if the quality of the electricity does not correspond to the standards adhered to in Finland, or if there have been continuous or repeated interruptions in the supply of electricity, and these interruptions cannot be considered minor when taking into account their reasons and circumstances. Individual customer is entitled to price reduction if electricity supply is faulty, the reduction amount accounts for at least two weeks distribution bill if the fault is based on interruption. Also immediate damages are to be compensated. Customer is expected to make claims of faulty electricity supply in order to receive compensations.

After the large disturbances of 2001, additional measures to ensure the rights of individual customer were, however, required. As a regulative measure, compensation payments alone were considered insufficient both to the customers and to the distribution companies to improve network reliability. Also the number of payments was small, because they were determined on a case-specific basis and hence the process was laborious. Consequently, standard compensations were introduced to complement price reductions and damage compensations caused by faulty electricity supply. This meant naturally that specific limits to reliable electricity supply had to be determined.

The amendment to electricity market act in 2003 states that electricity distribution companies are to pay compensations to their customers on interruptions longer than 12 hours. The standard compensations are defined as a stepwise increasing percentage of the distribution bill:

- 10 % of the distribution bill if the duration of the interruption is at least 12 hour but less than 24 hours,
- 25 % of the distribution bill if the duration of the interruption is at least 24 hour but less than 72 hours,
- 50 % of the distribution bill if the duration of the interruption is at least 72 hour but less than 120 hours, and
- 100 % of the distribution bill if the duration of the interruption is at least 120 hours.

The maximum compensation is 700 euros. Compensations are not paid in the event that the interruption is unavoidable within measures taken by the distribution company. If a customer receives standard compensation, he/she is not entitled to price reduction stipulated in the electricity market act. However, the standard compensation practice is considered to promote customers' opportunities to attain compensations in cases other than over 12 hour interruptions as the attitudes among distribution companies become more positive towards compensations.

The standard compensation practice is seen as a guiding tool to change distribution companies' investments and operational practices in order to decrease the number and time of interruptions [6]. Despite the network company's obligation to develop its network assigned by the Electricity Market Act, there has not been any significant trend towards an improvement in the quality statistics [7]. 90 % of the interruptions experienced by customers are caused by faults in medium voltage networks. Therefore, there is a certain justification to this development requirement. It is difficult to determine the extent to which the reliability should be developed. Minimising a customer's distribution bill and also the cost of an interruption to the customer give an indication of the obtainable level, but only on company-specific level. Therefore, a working group for Ministry of Trade and Industry has initiated the process of placing general goals for improving the reliability of electricity distribution. This work is still in process [7].

Provision to large disturbances

Large disturbances of the 2001 showed also the need to adequately prepare for extraordinary circumstances. The areas of responsibilities and tasks in large disturbances are planned in advance in provision plans. These plans are drawn up in every distribution company to ensure that operation is efficient in challenging circumstances. Provision plans are designed to minimise the effects of natural phenomena and society's exposure to loss of electricity supply. However, it should be noted that despite the media attention concerning large disturbances there has not been any evidence of an increasing number of storms [7].

Industry regulations

The Finnish electricity distribution industry itself has been active in defining guidelines for situations where electricity supply can be described as faulty. It has, among other things, given reference to weather conditions that can be considered normal for the purpose of liability according to Electricity Market Act. Regarding long interruptions (> 3 min), the industry's recommendations concern the durations of a single interruption in normal operation condition. In addition, different recommendations are applied depending on the cause of the fault. Table 1. illustrates recommendations for sufficient reliability in different operating conditions concerning long interruptions [8]. In the table, a city is defined as an area in which the cabling level is at least 75 %, whereas an urban area has cabling at least 30 % but less than 75 %, and finally, a rural area has a cabling level less than 30 %.

Table 1. Proposed fault limits for long interruptions.

Fault location \ Operating condition	Low or medium voltage network [h]	Distribution substation [h]	Primary substation and company's own regional network [h]
City	4	8	12
Urban and rural	8	8	12

Interruptions that are caused by faults in other than the distribution company's own networks are excluded. As can be seen from the table, the industry recommendations are stricter in the sense that compensations are recommended to be paid for shorter interruptions. Fault limit for primary substation is longer due to economical circumstances, because such a fault would mean extensive and long interruption should there be no back-up connection available.

Industry's view on the economics of customer compensations is that neither significant investments to the reliability issues nor resulting increase in distribution bill are not needed because the quality of supply is mainly good or at least adequate [8]. The improvement of reliability is however well received among the companies.

Updating economic regulation

In addition to defining an acceptable level of reliability, there is the opportunity to consider the introduction of the continuity of supply aspects in the economical regulation of electricity distribution business. Although one of the main goals of the quality regulation might be conceived as compensating the effects of efficiency requirements to the quality of supply, it also serves as a guiding tool for the appropriate level of reliability. The present rate-of-return regulation considers only reasonable capital costs and efficient expenses of the business, but interruption costs are

so far absent. They will, however, be taken into account when determining the new guidelines to be adopted in 2008. For the purpose of determining quality incentive scheme, the regulator investigated the quality expectations of different consumer groups.

The interruption costs figures

In a recently commissioned research project, there was an update to the parameters used to represent customer cost of interruption that correspond to the present quality expectations [9]. There seems to be a definite increase of cost estimates in the last ten years: the figures have doubled or even tripled. Interruption cost figures are applied both by the distribution companies and the Energy Market Authority when establishing investment and operational decisions. Power quality regulation has utilised interruption cost figures in several example cases, but these figures represent the situation on an average rather than the actual situations experienced by individual customers. Therefore, exact limitations concerning the maximum allowable number and duration of interruptions are often also necessary.

COST OF LARGE DISTURBANCES

The costs of large disturbance-induced law amendments are not limited to the standard compensations to the customers, but the actual economical burden to the distribution companies comes from repair costs of large disturbances.

Cost of compensations

According to calculations, the two storms that were the instigator in introducing standard compensations would have caused compensations amounting to 9–14 million euros [3]. The compensations of a worst-affected distribution company would have been 12 % of that year's revenue and the repair cost would have meant an additional 10 %. The cost of a large disturbance can prove to be high for a distribution company if its impact area consists of a large part of company's network. Some companies have opted to take insurances for compensation fees. In 2005, compensations were paid to 40 000 customers, the total cost of compensations being 2.1 million euros [1]. Previously, active customer participation was required to receive compensations, but now companies may automatically pay compensations.

An important factor to the distribution companies is the processing of standard compensations in the economic regulation. The Finnish Energy Market Authority has treated compensations as pass-through components, in other words, they are not a part of determining the reasonable return of the distribution business. Compensation fees can therefore be seen as an income distribution from a distribution company's clientele to affected customers. Therefore, companies' face only the risk of repair costs in large disturbances.

It was assumed that the cost of compensations and potential insurance payments would increase the bill of distribution charges [6]. However, the change in distribution companies' operational practices and more efficient operation in interruption circumstances were thought to minimise the effects of bill increases. At the time of the law amendment, insurance fees were expected to amount to a maximum of 25 € per customer. This would account for a 2–10 % increase in the annual distribution bill [6]. The cost of higher reliability level is therefore recognised by society.

Repair cost of large disturbances

The repair costs of the 2001 storms amounted to over 10 million euros, approximately the same amount as the standard compensations would have been [3]. In 2005, the network repair costs of the disturbances amounted to the total of 3.5 million euros [1].

Network improvements

A totally reliable network is theoretically achievable through cabling and using meshed network. The level at which the network companies are prepared for large disturbances and their economical effects varies according to the condition of the networks and unique circumstances, in which the company operates. Companies operating in rural areas are in particular risk because of overhead lines used for economical reasons. Placing lines next to roads minimises the risk of damages and improves reliability.

OTHER EXPERIENCES

Other countries experienced large disturbances in the beginning of 2000. At that time, the debate on reliability issues started in Sweden and continued after the storm Gudrun damaged the networks extensively in January 2005. In 2001, there were recommendations for customer compensations after an 12-hour interruption, but they were enforced only in 2005 [3]. Instead, a voluntary compensation system was first considered sufficient. In these recommendations, a target level for the continuity of supply was introduced so that interruptions longer than 12 hours would not be permissible, some special circumstances being excluded. This goal was to be met in ten years. Indeed, distribution companies paid voluntary compensations for the amount 65 million euros after the storm Gudrun. In addition the storm caused damages for more than 250 million euros leaving some customers without electricity even for weeks. The Swedish society's reaction to the storm was immediate and quite notable. In addition to the customer compensations similar to those paid in Finland, interruptions longer than 24 hours are not allowed from 2011 onwards. This will be a challenging task especially for distribution companies operating in rural areas when combined with incentives given by economical regulation for improving the quality of supply (mainly through cabling).

In Norway, there has not been any particular storm to start

the debate, but the introduction of new guidelines for voltage quality can be seen as a reaction to insufficient quality levels perceived. The continuity of supply issues has been present in economic regulation of distribution business for several years and there has been evidence of improved quality levels.

CONCLUSION

The expectations on continuous electricity distribution have become evident. Society has brought upon regulations guiding distribution companies so that they are prepared for major nature catastrophes. These regulations concern compensations to individual customers and development of distribution networks to be better prepared for large disturbances. The customer surveys show evidence of growing cost of interruption to the customer, and in this light, it is natural that customers call for adequate compensations. By reducing customer damages, distribution companies are responding to public demand, although the economical consequences of disturbances to the distribution companies are constantly increasing because of regulations. Societies' reactions and the consequences to the electricity distribution business will permanently give high importance to an uninterrupted electricity supply.

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