EVALUATION OF ORGANIZATIONAL AND TECHNOLOGICAL ASPECTS THAT AFFECT SERVICE QUALITY

Nazineh EASSA
Alexandria Electricity Distribution Company - Egypt
nazineh@hotmail.com

SUMMARY

The utilities are today turning their focus toward economy and profitability. This is the case in most countries even though the specific conditions are different. The purpose of this paper is to present a methodology for establishing strategic plans and enabling priority classification of actions to achieve the target values for the quality indices in the network of Egypt, while at the same time minimizing their economic impact.

Supply quality is the result of a series of organizational and technological aspects, that influence it to different degrees. The procedure is based on identifying the aspects that influence the quality, collecting and classifying the information available for each aspect, determining the indices that act on (indices associated with availability of supply and also with product quality (wave quality)), then calculating the cost of associated actions. This provides the following information: the marginal cost of unit improvement of the factor, the volume of the investment required for obtaining a certain degree of improvement. Using this criterion enables globalization of the effects of various factors while minimizing their associated cost.

INTRODUCTION

The re-structuring of utilities in Egypt which took place when passing from companies vertically integrated to companies with vertical separation of activities (generation, transmission and distribution entities are separated) implies a similar treatment as to service quality issues in different stages.

The organizational changes occurred in the electric sector have modified many technical, economic and legal approaches. This is specially true when it comes to service quality, which has gradually been deemed to be no longer related to the end user only and is now analyzed in terms of different stages of electric power production and transmission, besides the typical study carried out for distribution.

Technical aspects are not the only factors influencing network quality, operation and management also play an important role. The quality of supply has a large degree of inertia that affects each component in different ways, so that the efficiency of different actions may take more or less time to become apparent in the quality indices.

The economic analysis on power supply quality is a new branch of science, which employs an analytic method combining the electric energy quality with its economic profits. The study on the quality and profit will provide a guidance to improve and increase electricity production.

By means of quality cost analyses for power supply the paper presented information for the level of power supply quality of the network, the status of service quality at customer’s side and, evaluation of the effect of quality management in power supply quality, so that the correct strategies or policies of electricity production and distribution management are made to promote the economic profit.

PERFORMANCE INDICES OF THE POWER SUPPLY

Non-quality will have a cost in addition to that of the energy not supplied and the corrective maintenance required. This makes it necessary for utilities to introduce techniques to evaluate the economic indices associated with availability of supply (duration and frequency of interruption) and also with product quality (wave quality).

The following indices are considered for the availability of supply:

- Average interruptions duration experienced in a year by a customer (AID).
- Supply interruptions per customer per year (AIN).

The proposed targets for the (AID) are 3 hours in big cities, 6 hours in other towns and 15 hours in rural areas. The target values for the (AIN) are 4 cuts in big cities, 7 cuts in other towns and 12 cuts in rural areas.

In product quality, the standard limits adopted by Alexandria Electricity Company for the product quality indices that are used to assess different types of rms voltage variations are:

1- Voltage deviations:
   - $U_n = \pm 10\%$ up to 33 kV.
   - $U_n = \pm 5\%$ for normal case, $\pm 10\%$ for emergency case above 33 kV.

2- Voltage unbalance magnitude: 3%

3- Harmonic distortion of voltage: The THD of voltage equal to:
   - 5% Up to 69 kV, 1.5% (69 kV- 161 kV), 1% above 161 kV.

4- Frequency deviation : 1% for normal case and 2% for emergency case.

THE CURRENT SITUATION

Since the cost/ benefit ratios are functions of the current levels of quality - i.e. the higher quality attained, the more expensive is any further improvement - analysis of the current situation was carried out.

Alexandria Electricity Company has established a system for compiling the statistics for network incidents. An outage
A large-scale power quality-monitoring program was conducted, the principal objective of the program was to better understand the nature of the problems. A power quality database was developed. Fig. 5 gives the computed summary statistics of data sets, it shows the average values and the 95% values for each parameter.

The historical evolution of the outage time/customer/year & number of interruptions/customer/year over the last 5 years indicates a progressive improvement of these indices at a general level, and they tend to stabilize themselves at values close to the current ones.

For the product quality, a large-scale power quality-monitoring program was conducted, the principal objective of the program was to better understand the nature of the problems. A power quality database was developed. Fig. 5 gives the computed summary statistics of data sets, it shows the average values and the 95% values for each parameter.

The application of economic analysis aims at safe, reliable and economical power supplying to consumers with qualified electricity and increasing economic profits for the electrical company.

The procedure is based on identifying the aspects that influence quality, determine which indices they act on and to what degree and quantify the cost of the associated actions. Using this criterion enables globalization of the effects of various factors while minimizing their associated cost.

However, some specific peculiarities of the problem, the time factor for instance, prevent us from making a classic analysis. As is well known, supply quality has a large degree of inertia that the efficiency of different actions may take more or less time to become apparent in the quality indices. Supply quality is the result of a series of different aspects, that influence it to different degrees and are all necessary to attain it.
The factors that affect the supply quality should be identified, and applied with optimum efficiency so that they contribute in obtaining much lower values for the availability indices. These factors are:

- Control centers.
- Automatisms in substations.
- Construction quality standards.
- Planning criteria.
- Maintenance strategies.
- Co-ordination and optimization of planned outages.
- Management support (Information systems).

**COST-BENEFIT ANALYSIS**

To analyze the cost of quality associated with different actions, we need first to classify these actions. Actions could be classified as:

- Actions designed to improve product quality, which include the following elements that contribute to the improvement of wave quality: Reactive energy equalizers in substations, high short circuit power, and electromagnetic compatibility.
- Actions on planned outages, which include means for reducing the affected area such as co-ordination of work procedure means for preventing interruptions such as design of network structure and work live.
- Actions on accidental interruptions, which include the quality of workmanship, preventive maintenance, renovation of facilities, design of installations.

The paper includes in details the effect of some factors with greatest impact on supply quality such as maintenance, replacement and control centers. An evaluation of the relative effectiveness of these aspects on the improvement of quality was determined.

**Improvement Of Supply Quality By Maintenance**

In the 60\(^{th}\) and 70\(^{th}\) the electric power network was heavily enlarged due to the increase in energy consumption. The result is a large fraction of old components in the network for which maintenance is required or replacement is relevant in the near future.

The objectives of this maintenance are to extend the useful life of the installations and adapt overall maintenance costs to the general standard of quality. It should be designed to offer the necessary guarantees for supply availability under safe conditions without causing negative effects on the environment, to recover or improve the operation of equipment which have deteriorated and to restore the installations to acceptable operational condition.

The maintenance should not be restricted to only the "reactive maintenance" i.e., replacement of damaged parts. This is a low cost procedure and it tends to worsen the supply quality and on the long run increases the maintenance costs.

Maintenance of quality levels requires constant checking to keep the installations in acceptable condition. This cost is significant and is directly related to the volume of the installations, their working life and their location.

Maintenance designed to improve the quality involves verification, adaptation, and renovation. This is referred to as "proactive" maintenance to improve supply quality. The cost of this maintenance is very high due to the technological diversity of the elements installed.

Improvement of the supply quality by maintenance must be carried out through selective work based on replacement of material whose malfunction mainly affects the availability of supply.

A study have been carried out based on the selective replacement of the following elements:

- Medium voltage underground cables.
- Low voltage overhead lines.
- Low voltage underground cables.
- Distribution transformers.
- Terminals.

An evaluation for their relative effectiveness on the improvement of quality was determined. The results of the cost ratios associated with an improvement of 1 minute in the (AID) for an installed power of 1000 MVA are shown in Fig. 6.

![Fig. 6 Cost Ratios and Improvements in the (AID) Index](image)

**Control Centers**

In general, the benefits of the installation of automatisms are short term and must be complemented by other measures, because it does not cause any reduction in the number of the interruptions, and it does not improve the quality of installations.

The effects of automation are based on the incorporation of automatic or remote controlled switching and singling devices to detect easily the location of the fault or malfunction, so reduce the interruptions times.
It was possible to make an estimate for the cost / benefit ratio which is marked by the contribution of the worst lines to the interruption time index. The cost benefit study included benefits due to reduction in restoration time after unscheduled interruptions, remote monitoring, remote (substation-distribution point) operation, rerouting, re-conducting, reconfiguration and load management. This ratio was quantified for the network of Alexandria and was found to be 195 LE/1 min. 1000 MVA.

**CONCLUSION**

- Technical aspects are not the only factors influencing network quality, operation and management also play an important role.
- By setting up the indices of quality – cost for power supplying, the economic analysis for power quality can be carried quantitatively out.
- As a kind of commodity, electricity should also be guaranteed in high quality through the whole process from its design, operation to its utilization.
- In the process of network planning, the electricity production quality should be guaranteed from power demand prediction, power design, and project construction to the equipment putting in operation. And in the process of power utilization, great attention should be taken in " before – and after – sale " services.
- Power supply quality depends not simply on safe and reliable operation of the power network, but also should meet the requirement of applicability, efficiency, economy, reliability and remediable-ness. The economic analyses of power supply quality enable the quality to be in an " optimal " level.
- One of the important areas, where the role of economic optimization will grow, is maintenance and replacement of components in the networks. Maintenance and replacement is not only a question of technical matters, but indeed also of economic.
- New regulations regarding economic compensation to the consumers for energy not supplied to end users is coming up, and utilities are met with the bench-marking requirements. This will make a technical-economical optimal maintenance and replacement even more important.
- The study provides a starting point for more detailed optimization studies as might be carried out by a distribution company.

**REFERENCES**


