



Status determination of fault characteristics in medium voltage power distribution system

G. Hasançebi^{1,a}, M. Yeğin², K. Karaarslan²

¹Kocaeli University, Institute of Natural and Applied Sciences, Electrical Engineering, Kocaeli, Turkey.

²Kocaeli University, Department of Electrical Engineering, Kocaeli, Turkey.

Accepted 4 December 2018

Abstract

In 2017, a large number of users were de-energized due to the outages. In this paper, these outages have been examined. All outages taken occurred in the medium voltage power distribution system. The area of responsibility of the distribution company covers Eastern Marmara and Western Black Sea regions. Predictions were made about future-oriented solution methods with situation determination. The faults in the overhead lines constitute the majority of the outages, similar to the statistics in the world (1). The fact that most of the outages are caused by undetermined temporary faults indicate how important it is to switch to self-recovering networks immediately. It is clear that in today's world, digitalization is inevitable, and electrical power distribution companies need to quickly internalize smart grid solutions.

Keywords: Electric power distribution; outage management system; smart grids; self-recovering network.

1. Introduction

Distribution companies are the legal entities engaged in the distribution of electricity in a certain region defined in the distribution licenses, distributing electricity with a voltage level less than 36 kV. Distribution facilities includes all equipment from the transmission and the distribution connected generation facilities to consumer meters [2].

The main duty of the distribution system is to offer, operate and plan the electricity to the use of consumers and/or producers in an adequate, high quality, continuous, low cost and environmentally

friendly manner within the framework of the principle of not discriminating between equal parties [3].

In this context; improving the quality of supply continuity, which means offering electricity energy to the users of the distribution system with economically acceptable costs and the minimum possible outage frequency and duration, is one of the most important tasks of the distribution companies when viewed by the user [4].

2. Classification of outages

EMRA (Energy Market Regulatory Authority) has asked the distribution companies to record outages affecting all or part of the distribution system in order to monitor the fulfillment of this duty in a sustainable manner by the Distribution Companies.

Records of outages must include the following information:

- a) Location of outage,
- b) Cause of outage (for long interruptions),
- c) The source of the outage,

- d) Start date and time of outage,
- e) Number of low voltage and/or medium users affected by outage,
- f) Finish date and time of the outage,
- g) Duration of outage,
- h) In case of supplying energy gradually after the outage, the information contained in (a), (c), (e), (f) and (g) for each stage.

Distribution company records outages in the distribution system in such a way:

- a) According to the source of the outage;

^a Corresponding author; gokmen.hasancebi@sedas.com

- Transmission,
 - Distribution-MV,
 - Distribution-LV,
- b) According to the duration of the outage;
- Long,
 - Short,
 - Temporary,
- c) According to the reason of the outage;
- Force majeure,
 - Safety,
 - External,
 - Network operator,
- d) Whether the outage was announced;
- Announced,
 - Unannounced.

If we need to examine the causes of outages in detail;

(C-1) Force Majeure: Natural disasters, epidemics, war, nuclear and chemical fallout, the state of mobilization, civil uprising, attacks, terrorist movements and sabotages, strikes, lockouts or other workers movements and interruptions in the scale exceeding the capacity of the distribution company to affect a significant number of users and the reason of outages evaluated by the Board of EMRA as a result of force majeure on the grounds that the distribution company is not able to prevent, avoid or remedy, and that prevents distribution company from fulfilling its obligations as a reason.

3. Power system fault characteristic

Looking at the assets of the company, the total length of the medium voltage lines is 36,000 km, while the proportion of the overhead lines is 85%, while the length of the underground lines corresponds to the remaining 15%. While the total number of users is 1.75 million, the amount of energy distributed in the region is 9 TWh.

When the range of outages in 2017 are examined, the ratio of outages on overhead grids is 73%, while the rate of outages on cable grids is 3%. In addition, the number of malfunctions that cannot be prevented by the distribution company due to unusual weather conditions is 3%.

4. Solution methods of power system fault types

There are some methods to prevent the occurrence of short circuit events occurring on the overhead lines

(C-2) Safety: The reason for the necessary outages for the safety of life or property is defined as "safety".

(C-3) External: Provided to be certified by the distribution company;

- Outages caused by user-caused damages,
- Outages caused by theft, fire and 3rd party damages which results in failures occurred on the overhead or cable line, referred as "external".

(C-4) Network operator: The reasons for outages not included in the above (C-1), (C-2) and (C-3) paragraphs are stated as "network operator" [5].

Within the scope of the study; the outages, from 2017 which are in the MV distribution grid, Network Operator reasoned under the responsibility of the SEDAŞ, which was published on their website, has been examined and the predictions have been made for the future [6]. Outages due to other reasons has not been taken into account because it cannot be prevented even if the distribution company takes all precautions. Similarly, the outages in the low voltage distribution network are not included in the study because they affect relatively less people compared to the medium voltage level.

While 80% of these outages are due to phase-to-earth failure, 15% of them are due to phase-to-phase and 5% is due to three-phase fault [7].

In 2017, the minimum daily outage occurred in February, March and April respectively, whereas the highest daily outage was observed in July, June and August.

75% of overhead line failures are found to be a condition where temporary failures occur. In Table 1, the types and rates of outages in four cities in the responsibility area of the relevant distribution company are shown.

and the solution suggestions are presented in Figure 1.

Table 1: The percentage of outage in 2017

	Bolu	Düzce	Kocaeli	Sakarya	Grand Total
Network Operator	%73	% 64	% 77	%72	%73
Temporary Fault	%49	%42	%37	%44	% 42
Overhead Line Faults	%8	% 11	% 13	%10	% 11
Bird Electrocuting	%5	%4	% 14	%6	%8
Unavoidable Fault	%0	%0	%5	%4	% 3
Wind	%4	%3	%3	%2	% 3
Disconnecter Failure	%2	%1	%2	%2	% 2
Tree Contact	%2	%2	%1	%2	% 2
Cable Terminator	%1	%1	%1	%1	% 1
Ice Load	%1	%2	%0	%0	% 1
Surge Arrester	%1	%0	%0	%0	% 0
Advertising Removal from Grid	%0	%0	%0	%0	% 0
Moisture, Water & Humidity	%0	%0	%0	%0	% 0
Natural Disaster	%0	%0	%0	%0	% 0
Overloading, Circuit Breaker&Fuse	%23	%31	% 16	%22	%21
Cable Failure	%1	%1	%2	%2	% 2
Distribution-Power Transformer	%1	%1	%1	%1	% 1
Deterioration of Materials	%1	%1	%1	%1	% 1
LV Distribution Panel Failure	%0	%0	%1	%1	% 1
Circuit Breaker Failure	%0	%0	%0	%0	% 0
Protection Relay Failure	%0	%0	%0	%0	% 0
Cubicle Failure	%0	%0	%0	%0	% 0
The effect of Non-Avian Animals	%0	%0	%0	%0	% 0
Measurement Transformer	%0	%0	%0	%0	% 0
Debt – Cutting	%0	%0	%0	%0	% 0
DC System	%0	%0	%0	%0	% 0

5. Conclusions

Faults occurring in underground distribution lines corresponding to 15% of the MV lines of the distribution company are in the level of 3% of the total failure. The failure rate in the overhead lines corresponding to 85% of the network corresponds to 73% of the total fault. These ratios show that the outages of overhead lines are 4.3 times higher than the underground lines.

The temporary outages in the overhead lines are 55% of all outages and it is possible to prevent these outages by appropriate methods.

Finally, the increase in the number of outages increases in the summer period as opposed to the expected.

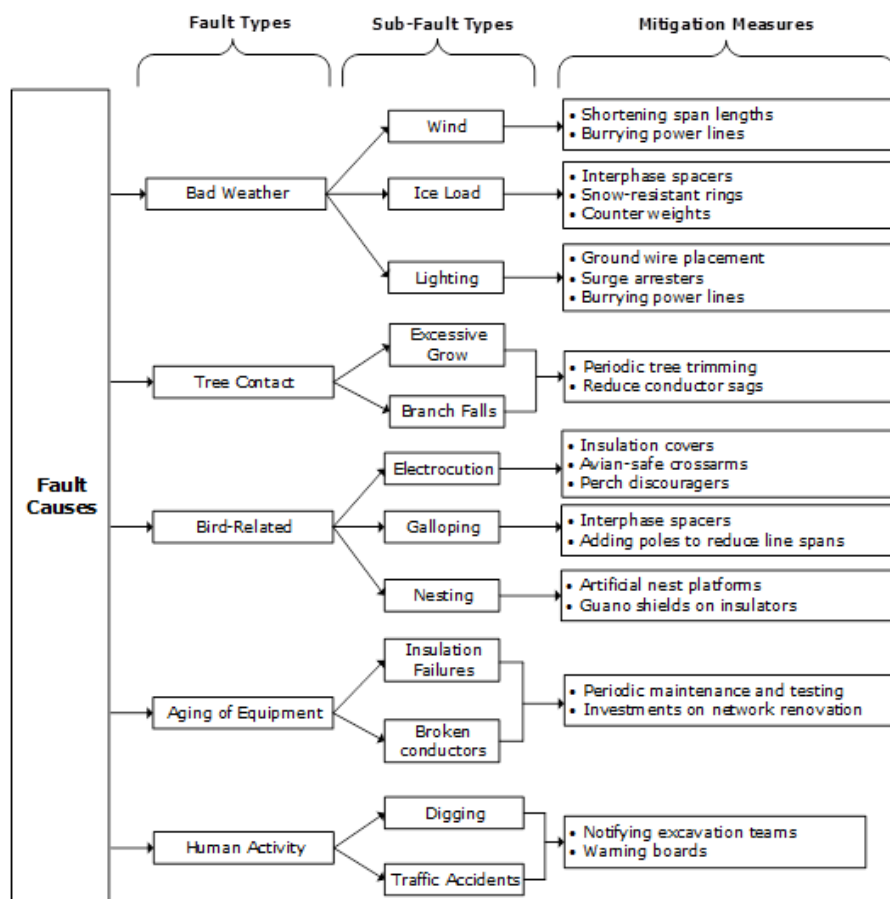


Figure 1: Power system failure types and solution methods.

6. Discussion

Both EMRA, as well as the customers expect from the distribution company to reducing the number and duration thresholds of outages as performance criteria. For this reason, it is necessary to abandon the management of distribution companies by traditional

methods and to make an evolutionary process that uses technology rapidly and closely. The transition to self-restoring networks in distribution systems is the most important milestone in this way.

Acknowledgement

As authors, for his contributions and support, we

would like to thank Mr. Önder Polat.

References

- [1] Azari R, Chitsazan M, Niazazari I. Optimal Recloser Setting, Considering Reliability and Power Quality in Distribution Networks. *American Journal of Electrical Power and Energy Systems* 2017; 6: 1-6.
- [2] Energy Market Regulatory Authority (EMRA), 2016, Electricity Market Connection and System Usage Regulation, Ankara.
- [3] Energy Market Regulatory Authority (EMRA), 2014, Electricity Market Distribution Regulation, Ankara.
- [4] Energy Market Regulatory Authority (EMRA), 2018, Electricity Market License Regulation, Ankara.
- [5] Energy Market Regulatory Authority (EMRA), 2017, Regulation on Service Quality for Electricity Distribution and Retail Sales, Ankara.
- [6] SEDAŞ (2018), was taken on November 20, 2018 at SEDAŞ: https://www.sedas.com/tr-tr/Bilgi_Danisma/Pages/Tablo1.aspx.
- [7] Wang L. The Fault Causes of Overhead Lines in Distribution Network. *Matec Web of Conferences*.