

CASE ANALYSIS OF LIGHTNING-CAUSED OUTAGES ON THE ENEDIS POWER DISTRIBUTION SYSTEM

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Context

- ENEDIS (previously ERDF) manages the public electricity distribution network for 95% of continental France :
 - 725.000 kilometers of overhead lines
 - 2240 substations
 - 750.000 transformers
- Some regions in France can exhibit a N_g equal to or greater than 4 Flashes/km²/year
- ENEDIS is using lightning data to automatically identify lightning-caused outages

Objectives

Analyzing real cases of lightning-caused outages occurring in 2015 on the Electricity Distribution System to :

- Measure delays and distances between lightning strokes and assets to tune settings of the automatic correlation software
- Check the performance of the Lightning Locating System

Outages and lightning data

51 lightning-caused outages mainly located in the south of France consisting of permanent failures

- Timestamping at a one second time resolution accuracy
- Position of the head-end station detecting the outage

Return strokes parameters collected by Météorage

- High resolution timing and location of individuals
- Verified LLS performance against video records
 - DEFlash = 97% (2015)
 - DEStroke = 94% (2015)
 - LA = 110 m (median value)



Geographical distribution of lightning-caused outages



Example of a multiple strokes flash correlation with closest part of the system

Correlation methodology

Lightning strokes occurring within ± 5 seconds in the vicinity (10 km) of the head-end station are collected in a raw dataset. Strokes exhibiting the smallest delay with the outage timestamp are selected and displayed in Google Earth to determine the smallest distance with the closest part of the system including power lines and the head-end station.

Results

- In all cases, the delay between lightning strokes and outages is 0 second : timestamping accuracy of outages and return strokes are reliable.
- Median distances between strokes locations and head-end stations and power lines are respectively smaller than 500 m and 100 m
- 90% of correlated strokes are of negative polarity exhibiting a mean value of 37 kA with 8% of the strokes being greater than 100 kA (against 13kA in average for 1st + subsequent strokes)

Domain ACR	Number of failures	Median dist. to head-end (m)	Stdev (m)	Median dist. to closest part (m)	Stdev (m)
Pau	4	560	524	51	57
Clermont-Ferrand	3	280	70	42	17
Aix	4	750	637	84	256
Bordeaux	19	369	304	42	144
Rodez	2	490	438	16	15
Ajaccio	19	495	928	45	86

To conclude

- Timestamping of outages and return stroke are crucial parameters for lightning-caused outages correlation : Zero second delay guarantees the quality of the correlation
- The distance between strokes and assets locations is subject to errors related to Lightning Location System and Assets geo-referencing accuracy. This parameter value must be adapted in the correlation system according to both uncertainties.
- For ENEDIS, it is recommended to use a correlation distance not smaller than 2 km since head-end stations serve as reference points for the spatial correlation.
- Another parameter to consider in the correlation process is the peak current