ECO-NETWORK – INNOVATIVE SOLUTIONS TO MITIGATE STORKS' ACTIVITIES IN THE VICINITY OF THE ELECTRIC DISTRIBUTION NETWORK

Pedro J. G. CARREIRA
EDP Distribuição – Portugal
pedro.carreira@edp.pt

Luís M. G. MARICATO
ISR-Dep. Electrical Eng.
University of Coimbra
luismaricato@isr.uc.pt

Vítor M. C. MADEIRA
Dep. Life Sciences.
University of Coimbra
vmcm@ci.uc.pt

Aníbal T. de ALMEIDA
ISR-Dep. Electrical Eng.
University of Coimbra
adealmeida@isr.uc.pt

ABSTRACT

The white stork (Ciconia ciconia L.) population has increased dramatically over the past decade in wet areas, in Portugal. As a consequence, stork nesting and roosting on the top of electricity poles result in frequent bird fatalities from electrocution and outages of power supply. These outages cause important economic losses to industrial customers, and furthermore to EDP Distribuição, on electric distribution equipment damage.

To mitigate stork fatalities on the main electric distribution operator and to improve the quality of service, the electric utility EDP Distribuição, and the Energy Service Regulatory Authority (ERSE) in collaboration with Institute for Nature Conservation and Forests (ICNF), had implemented stork's activities mitigation programs on electrical power distribution equipment to minimize stork fatalities and energy outages.

INTRODUCTION

The white stork (Ciconia ciconia L.) population has increased dramatically (52%) over the past decade in Portugal, recent estimation is that 11,694 white stork nests are occupied (Fig. 1), according to preliminary results of the 2014 national census of the species [1,3,5].

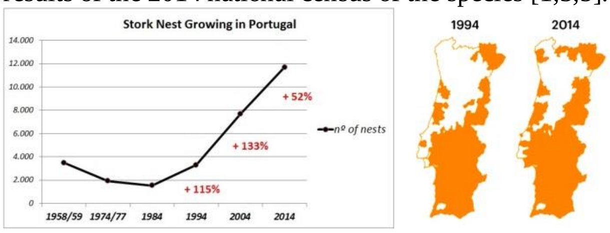

Fig. 1 - White Stork Nest growing and distribution in Portugal

Therefore, the demand for nesting and roosting in electric distribution equipment, e. g. poles, has also increased resulting in frequent bird fatalities from electrocution, and often create power supply outages, as a consequence of activation of automatic safety relay devices (Fig. 2).

Stork nests are constructed in sunny and elevated positions, like church towers, roofs and in the top of electricity poles. During the period of nesting, storks start to build the nest framework by setting down the basal layers with twigs and small tree branches, which can fall over overhead lines and create outages linked to flashover. Also, during the incubation period and until the end of nest occupation, food, excrements and branches fall over the overhead lines creating outages. These outages cause important losses to industrial customers which depend on computerized automation and other electronic control of production equipment. Furthermore, EDP Distribuição, in addition to equipment damage, is often involved with significant economic losses [3].

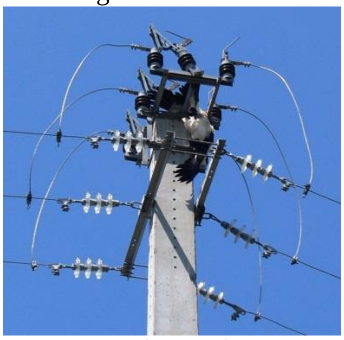

Fig. 2 - White stork fatality from electrocution

As an energy Distribution System Operator (DSO), fully committed to answer the needs and expectation of its customers, EDP Distribuição has been systematically developing efforts to adopt technical innovative solutions to increase the Quality of Service (QoS) minimizing energy outages taking into account the White Stork safety.

EDP Distribuição, as the main energy DSO in Portugal, being committed to incorporate respect for the environment and management of environmental aspects in all phases of business processes, increase the quality of energy distribution, and minimize outages and economic losses associated. EDP Distribuição operates approximately 84.000 km of High Voltage (HV- 60 kV network) and Medium Voltage (MV-10 to 30 kV networks) lines and cables with 80% in aerial topology [3].

From 2004 to the present date, EDP Distribuição, with ICNF, developed several campaigns to clean nests and residues from electrical poles, and the installation of anti-nesting devices or perching preventers all over the white stork areas and the relocation of nests on dedicated poles [1,3]. These campaigns are held each year, during October, November and December. Until now, the standard perching and nesting preventers in use are: the wind turbine, the 45º plates, the umbrella and the symmetric, asymmetric and triple chevrons (Fig. 3). Even though of implemented efforts (standard dissuasion devices) to decrease bird fatalities and bird power outages, nesting is still possible as shown in Fig. 4(a) and Fig. 4(c).

(a) (b) (c) (d) (e)

Fig. 3 - Traditional standard devices to prevent roosting and nesting of storks. From left to right: (a) umbrella + wind turbine; (b) symmetric chevron + 45º plates; (c) double umbrella; (d) bare conductors and tension clamps covers + covered conductors (jumpers); (e) platform on top of the tower + dedicated pole with platform

(a) (b) (c) (d)

Fig. 4 - Examples of white stork nesting, even when deterrent devices are installed. From left to right: (a) - wind turbine blocked by a stork nest; (b) - nest over insulators and lines; (c) - nest under chevron and over a high voltage switch; (d) – Large stork nest over power lines

Complementing an innovative culture with an environmental and social responsibility policy, the stork project involves EDP Distribuição, ISR-UC and DCV-UC in a pioneer implementation of novel produced or modified harmless technologies to prevent nesting: disturbing sounds, ultra-sound, vibration devices, powered turbines and recently micro electroshock dischargers.

Sound and ultra-sound devices are not fully effective on storks expelling. Most effective are harassment sounds (guns, sirens, alarms, dynamic musical pieces), which also have great social negative impacts. Powered turbines (Fig. 5(b)) and vibrating platforms (Fig. 5(c)) are very effective for roosting prevention, but require expensive power sources, and as mechanical systems, periodic maintenance is required, leading to additional costs [1].

(a) (b) (c)

Fig. 5 - Some of the technologies developed and tested. From left to right: (a) – sound system, (b) – motorized turbine, (c) – vibrating platform

STORK'S IMPACT ON POWER QUALITY

Outages exceeding 100 minutes registered by White stork incidents increased by 47% between 2009 and 2010, and increased again by 83% between 2012 and 2013 (Fig. 6 and Fig. 7). Moreover, bird activity incidents represent 6% of the total in the aerial network, and cause huge impact on the main Technical Service Quality (TSQ) indicators (Fig. 8) [1,2,3,4].

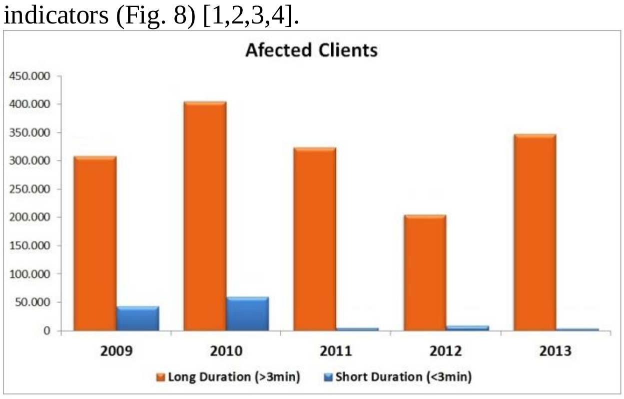

Fig. 6 - Total Number of customers affected by stork incidents and outage duration

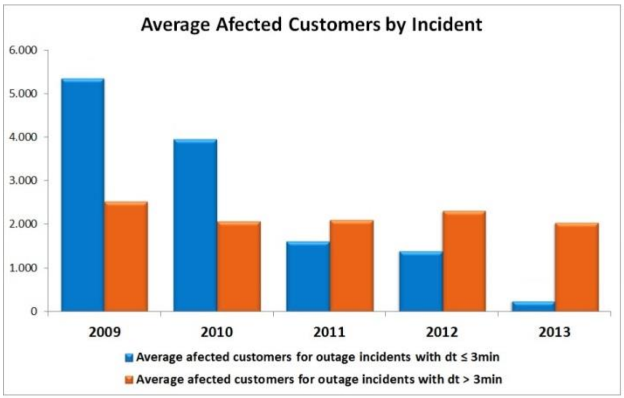

Fig. 7 - Average Number of customers affected per stork incidents

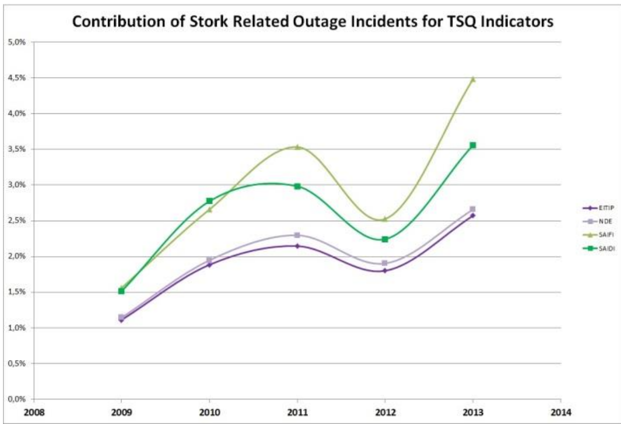

Fig. 8 - Contribution of Stork Incidents for Technical Service Quality (TSQ) - Power Quality Indicators: EITIP - Equivalent Interruption Time of the Installed Power; NDE - Not Distributed Energy; SAIFI - System Average Interruption Frequency Index; SAIDI - System Average Interruption Duration Index

These outages, for electricity users, are translated in an economic negative impact on all sectors of the economy. Some types of equipment are particularly sensitive to power disturbances (reduction of the voltage level or supply interruption). In particular, even short duration disturbances can affect computers, servers, industrial automation and other electronic controls, translating into very large economic losses [2, 3].

Customer study

As an example, one client recorded voltage dip, with an amplitude of 40% and duration of 178 milliseconds caused a stoppage of 120 minutes in an industrial production line [3]. Fig. 9 highlights the high severity of voltage dips (reduction of the voltage) on very sensitive equipment customer facility [3]. Voltage dips over 20% amplitude can affect the production line (Fig. 10) [3]. From the disorders reported by the customer, 59% are originated from voltage dips of amplitude larger than 50%. Most of these recorded incidents are directly related to white stork activities.

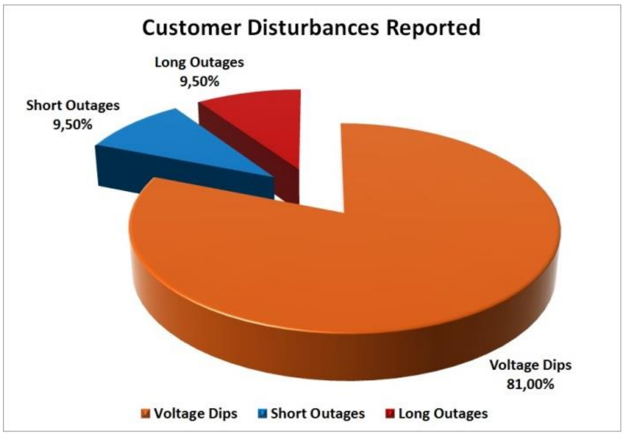

Fig. 9 - Outages in one industrial customer example monitored over one year.

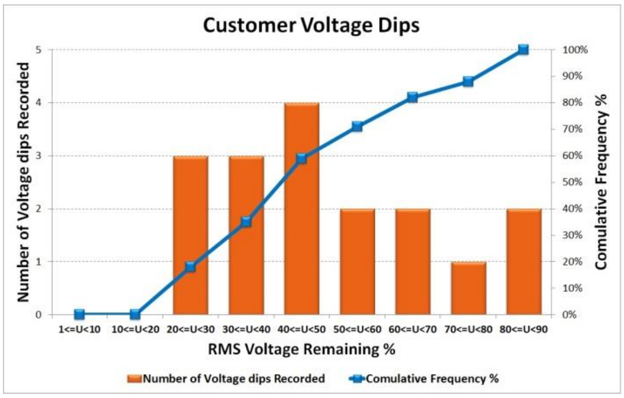

Fig. 10 - Customer voltage dips in one industrial customer

INNOVATIVE SOLUTIONS

Micro electrical shock systems associated with electrified landing structures are used to control the activity of storks. The main goal is to reduce the damage caused by stork's activity, while preserving them from electrocution. The technology presented is based on the controlled electric discharges with a very low amount of energy to the birds who try to land in the high voltage power structures. The bird will experience an unpleasant feeling without inducing any significant disturbance to his life. This technology is similar to the one frequently used to control small birds (pigeons and other) on monuments, cathedrals and other qualified buildings to prevent the damage from the droppings, nesting and perching. Another identical technology is the electric fencing used to maintain cattle in pastures. Synthesizing, this technology produces one unpleasant experience caused by the very low energy discharge, yet sufficient to induce discomfort, but completely harmless to the bird that is discouraged from trying a new landing episode (Fig. 12).

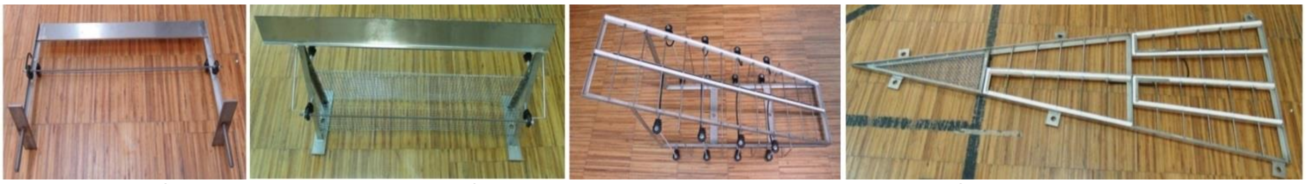

Fig. 11 - Electrified structures in test. From left to right: vertical; prism; oblique and oblique for metal pole

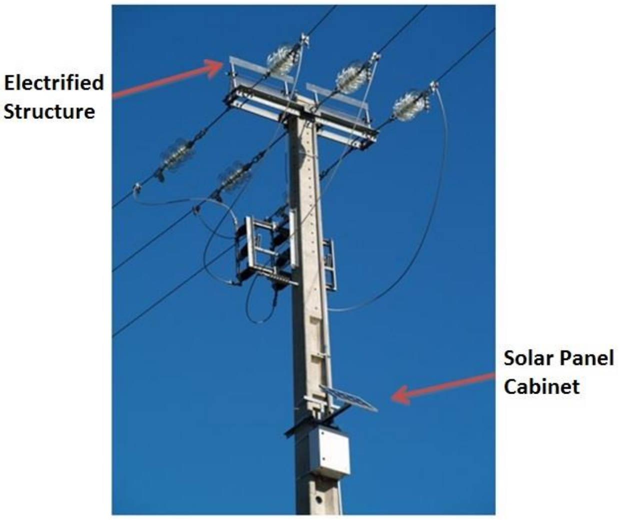

Fig. 12 - Installation model for a standard micro electrical shock system pole

Micro electrical shock system

The stork's management solutions involve the implementation of originally produced or modified harmless repelling technologies, which comprise:

i) a set of electrified structures developed according to the architecture of each pole and the support plates (Fig. 11);
ii) an electrifier equipment (Fig. 13);
iii) an independent power supply (Fig. 13);

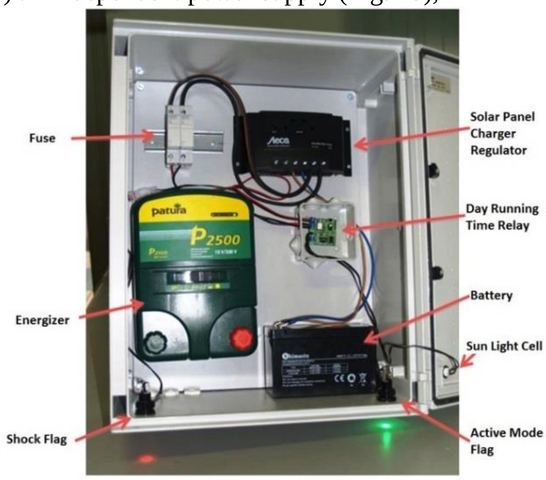

Fig. 13 - Standard equipment installation of micro electrical shock system

The energizer produce the precise amount of discharge energy that can be adjusted between 1 and 2 Joules at 9800 Volts, and also the time between discharges (1 or 2,5 seconds), associated to a solar activated switch for day running time only, saving battery once storks nesting activities are mostly during day light time (Fig. 13).
The independent power supply is one battery inside the cabinet witch is charged by a solar panel through a charge regulator (Fig. 13).
The system comprises electrified structures developed for each specific pole, together with the micro electrical shock electrifier equipment and autonomous power supply, represented on Fig. 12.

Electrified Structures

The electrified structures were developed to match the architecture of different types of pole structures, and to evaluate witch are the best solutions: vertical, prism and oblique types of poles, always taking into account to minimizing the impact on small species.

Vertical and Prism Structures

These structures were developed to meet thin poles, to be very light weight and very easy to install (Fig. 14). The electrodes are applied on the top of the structure to guarantee that the bird receives an unpleasant experience on the first landing time, and in this way discouraging a new roosting episode on the same place.

Fig. 14 – Vertical and Prism Structure

Oblique Structure

This structure is inspired on ladder type, with dual polarity rungs (10 kV and the mass). The stork, when landing, place a paw on the same rod at different polarities, or when placing a paw on each rung as if to move up or down the ladder, will be presented to one unpleasant experience.
The grid has a slope of 30 degrees to prevent the stork

depositing sticks or clumps when attempting to build the nest. The sticks will roll over and fall out the structure without interacting on electrical lines. This structure is best suited for concrete supports with larger faces (Fig. 15), since it increases the probability of placing a paw on each electrode.

Fig. 15 – Oblique Structure

Oblique Structure for metal poles

This structure has the same principle as the oblique structure, but for metal poles with inclined arms. Taking advantage of the beam to slope the structure, the application meets only portion of the electrified comb type or ladder type on the arm (Fig. 16).

Fig. 16 - Oblique Structure for metal poles

CONCLUSION

The practical experiments demonstrated that controlled micro electrical discharges, tested on a variety of birds, proved to be the most appropriate method to prevent electrocution and nesting. There are no records of negative impact on birds near all the installed equipment places.

Different types of solutions adapted to different tower structures proved to be effective.

It is concluded that the proposed technology was very effective to control storks roosting and nesting activity on protected locations, notwithstanding a few failed nesting attempts. It was observed that these micro electrical shock systems are highly effective on the white stork perching prevention, if the stork receives the unpleasant experience on the first landing approximation.

These micro electrical shock systems are very effective at any time of the year. However, the initial visits of storks to find their nest places may occur already by the second week of November, therefore it is recommended to have the equipment installed before this season.

Acknowledgments

The project was financially supported under the scope of PPDA (Plano de Promoção do Desempenho Ambiental da ERSE) planning, program 27 (Stork - protection strategy for avifauna) and EDP Distribuição. We are also indebted to ICNF (Institute for Nature Conservation and Forests), which is the governmental body responsible for nature conservation and biodiversity policies as well as the management of Protected Areas, for valuable contribution. We also would like to thank, among others, Acácio Rico, Margarete Garcia, Hernâni Vale, Magalhães Alves and Joana Bernardo for help and collaboration.

REFERENCES

[1] P.M. Araújo, L.M. Maricato, J.R. Loureiro, J.M. Batista, J.A. Ramos, , P.J. Carreira, J.M. Magalhães-Alves, N.M. Mendes, A.T. Almeida, V.M. Madeira, 2013, "Management of Stork Activities in Equipment of Electric Distribution Power Networks", *Environmental Engineering and Management Journal*. 12, 2311-2321.

[2] Avian Power Line Interaction Committee, 2006, *Suggested practices for avian protection on power lines: the state of the art in 2006*, Edison Electric Institute APLIC, and the California Energy Commission, Washington, D.C.

[3] P. J. G. Carreira, L. M. G. Maricato, N. M. S. C. Mendes, F. M. L. Bastiao, V. M. C. Madeira, A. T. de Almeida, 2011, "Management of storks and quality of Energy Service: Stork project", *11th International Conference on Electrical Power Quality and Utilisation (EPQU)*, 1 – 6

[4] Energy Service Regulatory Authority (Entidade Reguladora dos Serviços Energéticos – ERSE), 2014, *Qualidade de Serviço de Natureza Técnica no Sector Eléctrico*, Retrieved September 25, 2014, from http://www.erse.pt/eng/electricity/servicequality/Documents/SE-QS-QST-EN-VF.pdf

[5] Institute for Nature Conservation and Forests (Instituto da Conservação da Natureza e das Florestas – ICNF), 2014, *Preliminary White Stork Census integrated on "VII White Stork Mundial Census"* Retrieved September 25, 2014, from http://www.icnf.pt/portal/naturaclas/ei/cempa/pp-monit/cens-ceg-branc