



# ***Electric Energy T&D*** **MAGAZINE**

SEPTEMBER-OCTOBER Issue 5 • Volume 20

2016 Storm Restoration and Vegetation Management Supplement

**HOW LASER TECHNOLOGY  
SIMPLIFIES VEGETATION  
MANAGEMENT AND  
PROTECTS THE GRID**





# How Laser Technology Simplifies Vegetation Management and Protects the Grid

By Paul Adkins

## Highlights from the BRIDGE Energy Group Utility Industry Survey on Outage and Restoration Management

Besides the obvious safety implications of having adequate vegetation clearance from power lines, power companies often face heavy regulatory pressure to ensure they maintain compliance for these clearance mandates. Major events caused by falling trees and limbs, including widespread power outages and heavy property damage, can put power companies on the hook for millions of dollars just to restore order, let alone provide their regular daily service.

Ensuring adequate vegetation clearance from power lines for years never topped the priority list for energy companies and electric utilities, but massive blackouts in recent decades (most notably the 2003 East Coast event that left tens of millions without power during a steamy August stretch) have put extra importance on a working vegetation maintenance plan. These organizations now must fully understand the regulations surrounding vegetation management and implement a safe, cost-effective process to do so.

Today, the North American Electric Reliability Corp. (NERC) requires vegetation management that prevents encroachments under all expected line positions. In short, transmission line owners must determine the minimum distance between conductors and vegetation at various positions in the right of way.

However, the process of gathering field measurements to just identify problem trees historically has been expensive and extremely time consuming. But advances in technology have made safety and compliance much easier to achieve.

### Outage Notification

Recent survey results show that 81 percent of respondents have deployed smart meters for at least a portion of their customers. However, a closer look reveals that many utilities still rely on customer calls for outage notifications.

### Clearance Criteria, Then and Now

Historical vegetation clearance criteria has relied on calculating minimum distance between trees and conductors. But NERC requires minimum clearance distance between vegetation and the conductor in various

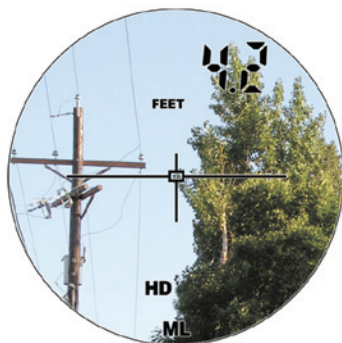
conditions for all expected positions in a power line's right-of-way.

The measurer, then, must account for a variety of transmission line positions based on sag and sway as environmental and weather conditions change, but the conductor often isn't visible from the ground because of extensive limb saturation and heavy foliage. So the conductor actually must be modeled to identify predictable but accurate line positions, and this requires a three-pronged approach:

- Ground patrols to identify potential vegetation encroachment and right-of-way clearing requirements.
- Aerial LiDAR to provide foresters with high-accuracy identification of what they can't see on the ground as well as historical data sets for analysis.
- Area-specific field inspections to analyze vegetation at any point along the transmission line corridor and conduct specific encroachment inventories.

The LiDAR data, based on input from the ground patrol, then delivers the actual location of the vegetation that violates the criteria, and the field inspections provides the added data needed to let the modeling software do its work and pinpoint the conductor location under those specific operating conditions.

Accurate data for vegetation management professionals truly relies on a variety of technology, all of equal importance in their own right. But a professional-grade laser rangefinder used for field work delivers precise distance, height and span measurements and helps prevent repeat aerial flyovers, saving companies time and money.



Follow-up field work is essential to locating and verifying the violation and the degree to which crews want to address it. Just like foresters often can't see what's above the tree line, aerial LiDAR can't see what's below it. But the two processes can work together in what's called ground truthing.

Ground truthing your clearances in vegetation management means the location, violation and terrain data revealed by aerial photography

are confirmed in an actual field check – on the ground. This process used to be very cumbersome, with heavy, bulky equipment being toted around arduous terrain and moved to multiple locations to get the measurements needed.

Advances in laser design and efficiency have vastly simplified the routine. Vegetation managers can evaluate and further analyze the LiDAR data using a handheld laser rangefinder at ground level and make adjustments to trimming plans right there in the field.

Think of all the time and money a utility company could save if its crews in the field could:

- Quickly identify specific areas of concerns
- Quickly identify large areas that are not of concern, which would eliminate the costs associated with surveying those zones
- Easily determine whether specific problem areas constitute routine maintenance or should be escalated as emergency violations.







With leading laser technology and effective ground truthing processes, a vegetation manager can do all of these things by confirming or adjusting data from previous ground patrols and aerial LiDAR right from the palm of the hand.

### The Total Laser Solution

The modern total vegetation management solution that utility companies rely on for vegetation management includes three components: a laser, GPS technology, and a computer. Laser rangefinders form the

cornerstone of the solution, which enables field crews to navigate to the troubled locations picked up by LiDAR flyovers.

Modern laser technology can measure distance, height, azimuth, horizontal angles, and missing line values, which are essential for vegetation management. Users shoot the top of a pole or a tree and measure slope distance and the degree of inclination. With the built-in inclinometer, the laser will calculate the horizontal and vertical distances, which

ultimately calculates a height value. Its integrated electronic compass technology also measures azimuth angles to a highly accurate degree.

Utilizing this compass or a horizontal angle encoder, the user takes two shots that capture the slope distance, inclination, and angle. These same values between the two shots are calculated internally, and the accurate distance and clearance measurements are delivered.

This delivers the most accurate readings for measuring clearances but also for calculating the missing line value. This important calculation determine spans between utility poles or clearances from conductors to encroaching vegetation, and lasers equipped with an electronic compass allow users to stand in a remote position and obtain accurate span values.

### How It All Works Together

A power or utility company will use this total solution, in coordination with its LiDAR surveys and modeling software, to identify vegetation violations and manage transmission line corridors. Once the aerial data gets loaded and vegetation clearances are identified, field inspections using laser technology measure those clearances to make sure they meet compliance and also ensure the software models run accurately.

The need for accurate models to determine conductor and transmission line sag and sway positions is critical, and laser rangefinders allow users to take a single shot of vegetation and let the software model work. The resulting data can be transferred to work management or GIS software and can be taken right to the field. The entire right-of-way geometry, including terrain and violations inventory for LiDAR data, also can be quickly accessed in the field. So armed with information identifying problem areas, crews can easily mark trees in violation of minimum clearance standards.

Utility foresters subsequently make on-the-spot determinations of vegetation clearance violations, conduct thorough violation inventories in the field, designate violations for immediate attention, audit completed work and carry out follow-up inspections.

Advantages of using leading laser solutions with advanced compass and inclinometer technology in vegetation management, then, include:

- Faster and safer inspections for crews because of the non-contact, long-range measurements that can be made.
- Improved crew routing, reducing downtime and improving efficiency.

- Single-shot technology to make one of the most trusted tools for verifying tree-conductor conflicts also the easiest to use.

### Summary

The required minimum-distance approach delivers a big picture of what power and utility companies must focus on for managing vegetation, but it's the laser technology that delivers the details necessary to maintain vegetation upkeep.

Revolutionary laser technology allows users to flexibly determine how and where to shoot from and will deliver the ultimate ease-of-use for vegetation management professionals looking for the most accurate field inspections.

The combination of ground patrols, aerial LiDAR, and total laser solution makes for more comprehensive vegetation management, and the advanced laser technology ensures accurate data to truly help power and utility companies meet compliance standards and safely deliver service in the most cost-effective manner.

### About the author



For over 15 years, **Paul Adkins**, Laser Technology's Global Communication Marketing Manager, has been involved with laser-based product and software development for industries such as electric utilities, construction, mining, forestry and geographic information systems (GIS). Paul earned his Bachelor of Science in Business Marketing and handles many facets of Laser Technology's marketing strategy worldwide.

# Keeping Animals Out, Keeping the Lights On

Electric utilities wage war against the growing trend of animal-caused outages

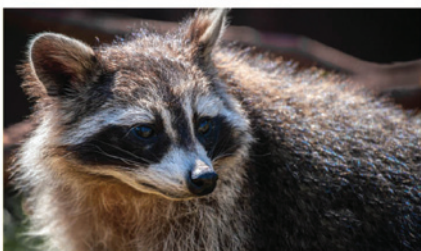
By Scott Beeler

Every year, property owners look to the skies in anticipation of the next summer storm or winter blizzard that might result in a potential power outage. The reality is, the next power outage is likely to come from something much closer to the ground.

Year after year, the intrusion of small, climbing animals into electrical substations adds up to billions of dollars in repair costs and lost revenue, and a succession of mild winters combined with a shrinking natural animal habitat is causing this problem to become more acute and something public power utilities can no longer ignore.

## A nationwide issue

Animal-caused outages are not simply a rural phenomenon: Squirrels, raccoons, snakes, domestic cats and other climbing animals cause substation outages in urban, suburban and remote locations across North America. A few notable examples – all of which occurred in within the past year and one-half:



Animals causing outages

In St. Augustine, Florida, a power outage caused by a squirrel damaging key components at a utility station led to a sewage backup, ultimately resulting in 60,000 gallons of untreated sewage flowing into the San Sebastian River.

In Richmond, Virginia, a squirrel short-circuited a substation, causing a massive power outage which threw sections of Richmond into darkness, disabling traffic signals at several major intersections, closing businesses and schools – including Virginia Commonwealth University – for most of the day.

In Seattle, a raccoon invasion of a substation resulted in the loss of power to 40,000 residents.

Smaller substation outages are commonplace. The satirical website [CyberSquirrel1.com](http://CyberSquirrel1.com), which was created to show that squirrels pose a much larger threat to the power grid than terrorism, tracks hundreds of outages across the U.S. every year. In fact, in 2015, a single power provider in Louisiana reported more than 700 outages caused by animals.

## Costs and challenges to the industry

The power producing industry has long felt the impact of outages caused by animals entering – and disrupting – substations. Substation incursions are a huge problem, and it's not getting any better:



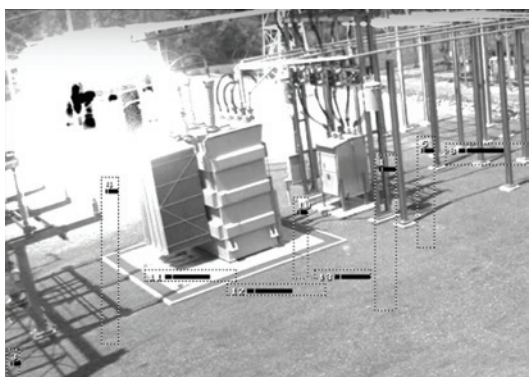
Complete installation: patented, modular design delivers mild electric shock preventing climbing animals from entering the facility



# Keeping Animals Out, Keeping the Lights On

Wildlife near power equipment is the most common cause of outages at public power utilities, according to the American Public Power Association. In 2015, squirrels caused 560 power outages... in Montana alone. On average, 13,000 people affected by an animal-caused outage. A single substation outage can cost tens of thousands of dollars in equipment cost, man hours and more.

Outages cost the U.S. economy an estimated \$80-188 billion every year in lost commercial activity, lowered productivity, consumer dissatisfaction and more.



Substation explosion caused by a snake

Utilities are recognizing that while the costs to do actual substation repairs are significant, the cost to repair a reputation is much higher – and they have taken steps over the years to install measures to keep climbing animals at bay.

Engineers and technicians have attempted to prevent or discourage incursions by using an array of methods: bushing guards, heat shrink tapes and tubing, spinning line guards, screening, repellants, greases, pole covers, lights, insulator coatings, decoys, and even live trapping.

These measures have had some temporary success, but they haven't provided permanent solutions. As an American Public Power Association representative noted in The Washington Post, "Animals aren't just smart, they're persistent."

## An effective, humane solution

Many substation operators are turning to an innovative, field-tested solution to the problem: the TransGard substation fence. The company manufactures and installs the only substation fencing that delivers a

humane – but effective – electric shock that deters climbing animals, an approach the IEEE calls the most effective barrier against animal incursion.

The fence was designed exclusively for substations: it's modular, durable, and installs in half a day without any interruption to power. To date, the company has installed fencing at more than 2,500 North American substations – substations operated by dozens of major utilities, electric cooperatives, municipalities and other power suppliers.

The technology behind the fencing uses an animal's own behavior against it. Squirrels, for example, have a habitat that can stretch across acres. They also have very accurate 'spatial memory' – that is, a knack for remembering key locations and landmarks in their environment. Squirrels need this spatial memory for survival – it's how they remember where they've hoarded small caches of food throughout their habitat.



Eastern grey squirrel. Good spatial memory to know what areas to avoid

Just as squirrels remember where they stored their food, they also remember where they received an uncomfortable jolt at a substation. A squirrel's "spatial memory" means it can remember where that uncomfortable experience happened — and also remember to avoid the unpleasant sensation the fence can cause.

## In the field: Protection for power providers

Dozens of electric cooperatives, municipalities and other power providers across North America have installed this high-end fencing. A few examples illustrate the scope of the animal outage problem for substation operators – and the technology's effectiveness in the field:

## Keeping Animals Out, Keeping the Lights On

**Rochester Gas & Electric (RG&E)** operates some 165 substations and provides electricity to 362,000 residents and businesses in upstate New York. In the early 1980s, RG&E began searching for ways to address a growing problem of outages caused by squirrels and raccoons entering substations. Besides disrupting service to customers, each damaged substation translated into a cost of approximately \$10,000 for RG&E in repairs. RG&E began a system-wide installation program in 1999, and since then has installed TransGard fences in all of its 165 substations with exposed bushings, insulators, conductors or other components within an animal's reach from the ground. The company estimates it has saved hundreds of thousands of dollars in costs associated with substation outages.

**Western Farmers Electric Cooperative (WFEC)**, which manages more than 400 substations in Oklahoma, New Mexico, Texas and Kansas, had been plagued for decades by repeated substation outages caused by the incursion of bull snakes, resulting in \$15-20,000 in lost revenue and repair costs with each outage. After seeing the specially-designed snake panel, WFEC technicians placed a 'test fence' around a problem substation in central Oklahoma. The application of the fencing proved to be easy and effective, and the fencing is now standard on all new substation construction.

**West Kentucky Rural Electric Cooperative Corporation (WKRECC)** supplies energy via 12 substations to approximately 38,000 members across five counties in Western Kentucky and Tennessee. The cooperative had been experiencing a frustrating number of recurring outages due raccoons, snakes and cats causing repeated damage at the same substations. After experiencing success with its first fence in late 2014, WKRECC has installed fences at 9 of its 12 substations and is working toward adding fences to the remaining ones.

**Mishawaka Utilities** electric distribution system is the second largest municipal utility in the state of Indiana, providing service to a population of 46,557. In 2001, Mishawaka began to explore

the application of animal deterrent systems for one of its substations that had been experiencing a high number of outages caused by squirrels. Mishawaka observed the new installation for a full year, and during that time there were no instances of animal-related outages. Mishawaka installed the fencing on three additional substations that had been experiencing a high number of animal-related outages. Since that time the company has experienced no animal outages on any of the substations protected by the high-tech fencing.

**Ameren** is the largest electric utility in Missouri and the second largest electric utility in Illinois, maintaining 2,400 substations and servicing approximately 2.4 million customers across both states.

At least 50 percent of the Ameren's Illinois substations were at high risk for damage from squirrels, raccoons, opossums and even snakes. In 2003, Ameren looked to this latest technology for help in solving their animal-related outage problems and installed fencing at a handful of substations. Since that time, Ameren has applied the system to more than 200 of their most at-risk sites. Ameren has not experienced an animal-related substation outage with the fencing properly installed and intact.

With human activity driving the reduction in size of animal habitat and utilities adding new substations every year to meet public demand, animal incursion will continue to represent a costly challenge. By exploring cost-effective deterrents that have a proven track record in the field, substation operators can mitigate the expense of animal substation outages -- and the inconvenience they cause customers.

### About the author

**Scott Beeler** is a communications consultant working with leading companies in the energy market