
ELECTRIC INFRASTRUCTURE

TREES AND ELECTRIC POWER LINES

Infrastructure Knowledge and Technology Conference

IKT – Institute for Underground Infrastructure
Gelsenkirchen, Germany

September 16-18, 2014

Duke Energy Corporation



- ❖ Primary business is generation and distribution of electricity
- ❖ 7.2 million electric customers in the United States
- ❖ Approximately 1 million natural gas customers
- ❖ 32,000 miles (51,000+ km) of high voltage power lines
- ❖ 262,000 miles (420,000+ km) of lower voltage power lines
- ❖ Numerous other business interests in South America, the Middle East, Canada, Central America, and Europe

International Right of Way Association

The IRWA is a not-for-profit association with a current membership of over 10,000. The IRWA promotes education and strong ethics, while serving all parts of the ROW industry:

- a) Electric & Utilities
- b) Pipeline
- c) Transportation
- d) Public Agency
- d) Asset Management
- e) Surveying & Engineering
- f) Relocation
- g) Environmental
- h) Valuation/Appraisal

Members:

- a) Land agents, attorneys, surveyors, appraisers, engineers, relocation specialists, project managers, CEO's, etc.
- b) Companies and agencies of all sizes are represented: ExxonMobil, Verizon, Saudi Aramco, US Army Corp of Engineers, City of Los Angeles, the Japan Compensation Consultant Association, as well as many small, owner-operator companies
- c) Located in North America, Africa, Europe, Latin America, Australia, Asia, and the Middle East

Trees and Electric Power Lines

How can we estimate the number of trees in a forest, the number of trees in a park, the number of trees in a city, the number of trees in a country, the number of trees in the world?

$$A + B = C$$

$$\text{Number of trees in a forest} = (\text{Number of trees in a park} + \text{Number of trees in a city} + \text{Number of trees in a country} + \text{Number of trees in the world})$$

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Trees and Electric Power Lines

Scope of the Problem

- “Tree - Power Line” contacts are the single most common cause of power outages in the United States.
- Financial damage costs approach ten billion dollars each year.
- Results of these contacts include deaths, personal injuries, damage to property, forest fires and destruction of animal habitat, and interruption of industry & business activity.

Trees and Electric Power Lines

**Everybody's First Suggestion: “Put All Electric Lines
UG”**

a) In new housing developments in the United States, it is common practice in many areas to place all new low voltage power lines UG.

b) However, high voltage power lines are almost never built UG in the United States except where circumstances prevent OH construction:

Examples of those circumstances:

- (i) areas near airports,
- (ii) downtown urban areas,
- (iii) situations such as new research parks where customers are willing to pay the additional costs for UG construction

c) Note: Some electric utility companies are now beginning to evaluate UG construction option for high voltage line based on weather issues (hurricane locales, etc.), infrastructure congestion situations where there is less available R/W

Trees and Electric Power Lines

So What's Actually Stopping Companies from Putting Their High Voltage Lines UG?

Expense: Primary reason for OH versus UG is excessive costs:

**Mandate from governmental regulators to control costs on projects*

**NCUC Study: Transition to put all NC low voltage lines UG would take ~25 years, require 5,000*

*additional employees, and would cost billions of dollars and **customers did not want to pay the cost.***)

- ❖ Engineering: a) Heat dissipation issues with different soils and high voltage
b) Ground fault issues (e.g. electric and gas lines)
- ❖ Congestion: Conflicts with other infrastructure (both above & below ground)
- ❖ Topography: Mountain slopes, bedrock, future access for maintenance
- ❖ Environmental: Initial construction destroys wetlands, river banks, etc. and future repair work damages sensitive environments each time work is needed
- ❖ Reliability: Outages are less frequent with UG lines, but outage issues require much longer time period to locate and repair when they do occur

Trees and Electric Power Lines

Monitoring of Power Lines

How it is accomplished:

- a) Satellite GPS and Imagery
- b) Helicopter: Duke Energy practice is to inspect all high-voltage lines every 180 days
- c) LiDAR (remote sensing technology that combines laser and radar)
- d) Manual inspections: Duke Energy practice is to have a two-person team inspect all lines annually.
- e) Infrared cameras
- f) High voltage power lines are continuously monitored digitally.



Trees and Electric Power Lines

Eliminating and Reducing Contacts:

Increase the distance between trees and power lines

i) Environmentally acceptable herbicides

- *Currently, a standard practice by electric utilities
- *Herbicides are continually being researched & evolving
- *Some areas where spraying can not be done

ii) Tree clearing / trimming

- *Currently, a standard practice

iii) Educating landowners

- * Most large utility companies acknowledge a disconnect between them and the public concerning “Best Practices” and standards of vegetation management
- * An approach with great potential for improvement
 - + Landowners continually landscape their properties giving great challenges to vegetative management personnel and increasing risks to the electric system

Trees and Electric Power Lines

Eliminating and Reducing Contacts:

Increase the distance between trees and power lines

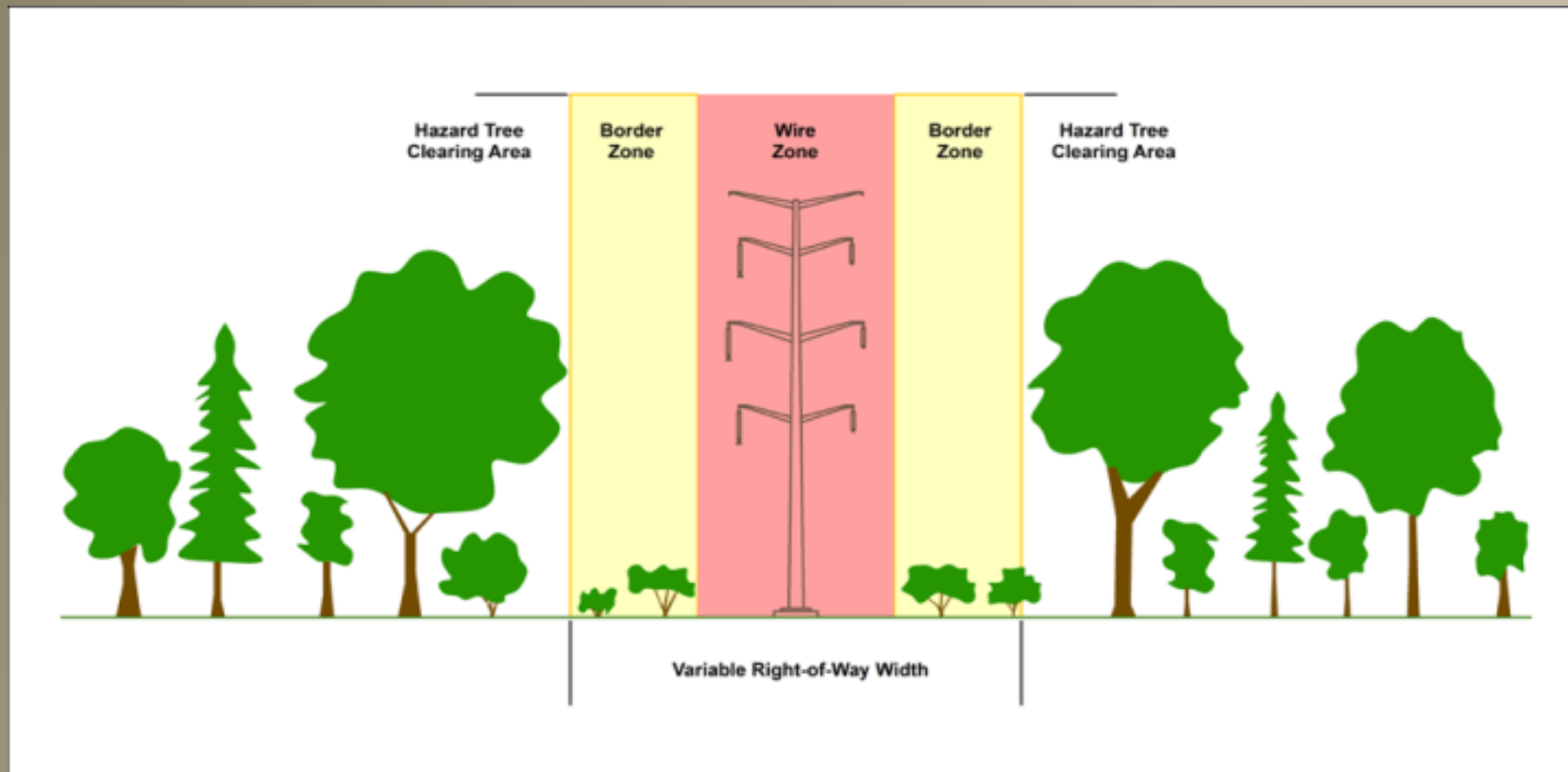
(continued)

- + Owners are increasingly more aggressive with respect to their land rights and the court system for problem resolution
- + Increasing urbanization increases utility/owner conflicts
- + Education of public about “Best Practices” would be helpful:
 - a) to learn what types of trees are compatible with power lines and why some trees endanger the local power supply
 - b) in meeting public’s desire for “Green” solutions,
 - c) in increasing carbon-sink goals
 - d) in improving relationship between public and utilities

Trees and Electric Power Lines

Maintaining A Safe and Clear Zone Near Electric Lines

Power Lines Physically Move Almost Continuously—Up, Down, and Laterally



Trees and Electric Power Lines

Examples of Management Options for R/W Vegetation

There are multiple approaches to address maintaining clearance near lines depending on the situation, such as:

*An area that's part of a golf course, company installed landscaping, customer maintains the area.



Trees on high voltage power lines are commonly removed at ground level. Debris is left to biodegrade in an environmentally safe manner.

Sometimes in residential or maintained areas, debris is chipped and bigger pieces are cut into short lengths and left with the property owner for their use and/or sale.

*Rural area where brush is left to bio-

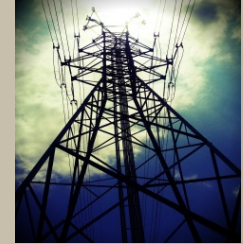


in an environmentally desirable manner.

Trees and Electric Power Lines



Damage to Electric Infrastructure



- ❖ Other primary sources of danger for an electrical system: ice and wind.
- ❖ Both factors cause damage to the power line equipment themselves, but in addition, they also cause extensive damage annually via tree falls.
- ❖ It's estimated that approximately 85% of tree-related outages are caused by trees from outside of the easement area
- ❖ Tree falls hitting power lines are a primary source of power outages in the USA. It is not possible to protect existing facilities against tornados with wind speeds of 200+ mph (320+ km/h) or hurricanes with winds >150+ mph (240+ km/h) and a 15-20' storm surge (~6 meters).
- ❖ Millions of dollars in damages is done to manufacturers by outages and to companies via lost inventory (spoiled food, etc.)

Trees and Electric Power Lines

Risks Near Electric Lines

Center of Photo Shows Cable from Truck Made Contact with Power Line.
Same Result When a Tree Make Contact with Electric Lines



As a result of 'tree-power line' contacts, trees often catch fire and then become large, devastating forest fires. In the Western US, summers are commonly dry and windy which leads to large forest fires, tens of millions of dollars in property damage, injuries, and deaths.

Trees and Electric Power Lines

Social Ecology: The “People Factor”

1. It is frequently presumed (even before contact is made) that citizens will be adversaries...and they do
take on that role based on how issues are handled by infrastructure company and agency personnel.
2. Very common for politicians to be ‘used’ by advocacy groups and others to achieve goals
3. Politicized projects result in increased costs, bad publicity, lost good will, and delayed schedules.
4. Citizens can be cooperative when viewed and treated as “partners” in project planning and development. This is not always an easy process, but when used, it has proven its value and keeps
projects from getting stalled by unexpected challenges to the project.
5. Concerning vegetation and tree clearing, a survey of landowners revealed that they would support
wider clearance of trees for power lines based on cooperative discussions (this practice is estimated
to potentially reduce storm damage & restoration expenses by approximately 50% along the east
coast of the US).
6. While the survey and study efforts mentioned earlier were directed at electric power lines, the