Vegetation Management

Resilience Investment Guide

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GRID DEPLOYMENT OFFICE

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Resilience Investment Strategy Overview

This resilience investment guide is one of six guides that describes the costs and benefits of a range of projects that are eligible under the Grid Resilience State and Tribal Formula Grant program and the Grid Resilience Utility Industry Grant program as described in Section 40101 of the Bipartisan Infrastructure Law (BIL). These two U.S. Department of Energy (DOE) grant programs are designed to enhance electric grid resilience against extreme weather, wildfire, and other natural disasters and are intended for states; federally recognized Indian tribes, including Alaska Native Village and Regional Corporations; U.S. territories; electric grid operators; electricity storage operators; electricity generators; transmission owners or operators; distribution providers; and fuel suppliers. This specific guide provides an overview of vegetation management practices.

Vegetation-related impacts to the power system are the most common cause of power outages in the U.S., accounting for more than twenty percent of incidents [1,2]. Effective vegetation management practices reduce the occurrence of these events through the implementation of:

- **tree pruning**, usually on a regular cycle – cutting back tree growth to maintain clearances from utility transmission and distribution overhead lines.
- **tree removal** – taking out damaged, unhealthy, or dead trees in proximity to utility lines.
- **vegetation control** – removal of flammable brush and suppression of hazardous brush growth.
- **integrated vegetation management** – combining the previous methods with other measures that promote “desirable, stable, low-growing plan communities that will resist invasion by tall-growing tree species through the use of appropriate, environmentally-sound, and cost-effective control methods” [3].
- **widening rights-of-way** – this would require the approval of local and state governments, but widening the area around utility poles and wires, where the utility is allowed to trim trees could significantly reduce vegetation related outages. The state of California, for example, has several laws for distribution line vegetation management, requiring greater distance (4 ft vs 1.5 ft) between wires and vegetation in “state responsibility areas” (typically non-urban, at fire risk locations) and a minimum of 10 ft clearance around utility poles [4].
- **“enhanced” vegetation management** – practices using technologies and methods that enable shifting from fixed-cycle vegetation management to the use of reliability- and risk-based criteria [5, 6]. These include using LiDAR and satellite imagery to capture vegetation conditions and AI/machine learning analytics to determine which vegetation needs to be prioritized for trimming [7, 8].

These enhanced practices typically involve more aggressive reductions in tree and plant growth.

Strengthens grid reliability and resilience by:

- Preventing initial outages

Improves performance against these hazards:

- Vegetation
- Animal
- Tornado
- Thunderstorm
- Hurricane
- Derecho
- Wildfire
- Ice/Snowstorm

Figure 1. Transmission line tree clearances

Advantages

Because vegetation can impact powerlines due to numerous hazards (branches snapping in ice, blown over in strong winds, and burned close to lines), good vegetation management can reduce outages across a wide range of mild to more extreme events. In an analysis of Duke Energy circuits in North Carolina, researchers found that increasing the frequency of trimming the same section of line by one year (for example going from every 4 years to every 3) would likely lead to a 13% reduction in vegetation related outages per month[1] [9]. Additionally, an electric cooperative in the Midwest saw improvements in reliability and decreases in maintenance costs after installing a vegetation management software solution to better track and analyze vegetation impacts on their system. Specifically, they were able to reduce spending by roughly 80% on trimming, while also reducing tree-related outages and duration of those outages by 30% and 45% respectively [10]. Lastly, Bonneville Power Authority in 2008 compared vegetation inspection practices along transmission lines and found that LiDAR inspections were the most accurate in locating clearance violations, although it is roughly 2-3 times more expensive than traditional patrol inspection [11].

When considering the benefits of vegetation management to more extreme events, a Connecticut study found that enhanced tree trimming resulted in a 16-48% reduction in outages during extratropical storms[2] and thunderstorms [12]. Additionally, vegetation management has also become an increasingly important component of wildfire prevention, both through clearing of flammable brush near power lines and maintaining clearances to prevent equipment-caused ignitions [13].

Disadvantages

Vegetation management is subject to utility rights-of-way, which are not always well-defined and may otherwise be subject to dispute by property owners [14]. Often it is vegetation debris that come from plants outside the utility rights-of-way that cause the most damage in extreme events. For example, post-hurricane analysis in Florida indicated that for vegetation management to be impactful in category 3-5 hurricanes, increasing frequency of trimming would not be helpful without wider rights-of-way [15]. In addition, tree measures may have aesthetic impacts that cause community resistance to them being undertaken [16]. For example, an undergrounding program by the Pepco utility in Washington, D.C. was motivated in part by the goal of reducing conflicts with residents regarding the effects of vegetation management on the District's tree canopy [17].

Costs

Table 1 gives several examples of vegetation management program costs per mile. It should be noted that total costs of such programs also depend on the frequency of the activities. For example, Xcel Energy Minnesota follows a five-year vegetation management cycle. Duke Energy Florida's cycles are three years on feeder systems, five years on laterals, along with annual "patrols" to identify and remove hazardous trees. Florida Power & Light follows a three-year cycle for most feeders, with some – e.g., faster-growing species – on a more frequent mid-cycle schedule, and a six-year cycle on laterals.

[1] Although this analysis excluded major event days (MEDs), they allowed for more "extreme" events to be included than are typically considered because the methodology for defining what is a MED differs from the IEEE standard.
[2] Occurring when cold air masses interact with warm air masses, over land or water.

Table 1. Examples of utility vegetation management program costs

Utility	Investment Type	Period	**Average Cost** (per VM cycle, nominal dollars averaged over time periods)
TNNP, Entergy Texas, Oncor, Centerpoint, AEP Texas Central, AEP Texas North, SWEPCO (Texas)	Distribution	1998-2008	$3k-$12k/mile [18]
TNNP, Entergy Texas, Oncor, Centerpoint, AEP Texas Central, AEP Texas North, SWEPCO (Texas)	Transmission	1998-2008	$0.3k-$9k/mile [18]
Baltimore Gas & Electric, PepCo, Potomac Edison (Maryland)	Distribution, transmission, and substation supply lines	Circa 2013	$6k/mile [14]
Xcel Energy (Minnesota)	Combined distribution and transmission	2018-2020	$8.7k/mile [19]
Duke Energy Florida	Distribution	2023-2025	$11k/mile [20]
Duke Energy Florida	Transmission	2023-2025	$42k/mile [20]
Florida Power & Light	Distribution	2023-2032	$4.7/mile [21]
Florida Power & Light	Transmission	2023-2032	$1.5/mile [21]

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