Utility Pole Maintenance and Upgrades

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 pole-related measures for improving transmission and distribution reliability and resilience.

The three general types of pole-related measures are: i) enhanced and/or increased inspection and maintenance of existing wood poles, ii) replacement with thicker and/or taller pole (aka higher-class pole) and iii) conversion of wood poles to other materials that are stronger and last longer.

Improving inspection and maintenance is based on better methods for distinguishing among poles that i) show no decay; ii) are decayed but can be serviced and remain in use; and iii) are decayed to the point of requiring replacement [2]. Traditionally, utilities relied primarily on "non-conditioned" inspections, which determine only the presence or absence of decay. Increasingly, they are moving to "conditioned" methods, which go on to excavation to determine the extent of the decay [2].

Distribution utilities usually replace wood-with-wood when replacement is required[1], installing stronger poles. These stronger poles can better withstand extreme weather but are less expensive than installing a non-wood pole [6].

When replacing wooden poles with other materials, utilities will usually choose steel for transmission infrastructure and sometimes use concrete [8,9,10,11,12]. For distribution systems, utilities may also consider ductile iron or fiber reinforced polymer (composite) poles [13,14,15]. All of these non-wood materials, can withstand higher windspeeds, are more fire-resistant, last longer, and withstand damage from wildlife and insects better than wood poles [9,13,14,15].[2]

[1] There are an estimated 130 million wooden utility poles in the US out of roughly 180 million total utility poles [20].
[2] In all cases, repaired, reinforced, or replaced poles of any material type increase safety by preventing injuries – including occasional electrocutions – from downed poles.

Strengthens grid reliability and resilience by:

- Preventing initial outages
- Replacing aging infrastructure

Improves performance against these hazards:

- Vegetation
- Animal
- Vehicle
- Tornado
- Thunderstorm
- Hurricane
- Derecho
- Flooding
- Wildfire
- Earthquake
- Ice/Snow Storm
- Equipment Failure

Figure 1. Downed utility poles and power lines in Louisiana following Hurricane Ida in 2017 [1].

Advantages

Specifically, when it comes to pole inspections, the National Association of Regulatory Utility Commissioners (NARUC) has found that more accurate inspection can substantially reduce the need for pole replacement [3]. DTE Energy's Pole and Pole Top Maintenance and Modernization Program moves beyond the utility's previous replacement-upon-failure protocol for wooden poles with more frequent and intensive inspections to identify poles in need of repair, facilitating reinforcement, when possible, rather than replacement [4]. Florida Power & Light (FP&L) has also moved to a conditioned-based approach to pole inspection, repair, and replacement [5].

When it comes to pole replacement, the primary advantages of selecting non-wood materials for replacement is that they can be more resilient to extreme events, lighter in weight (except for concrete poles), have longer lifetime because they are resistant to rot and decay, and also avoid environmental concerns of wood poles, which are treated with preservatives [8,9,13,14,15, 20]. For example, Southern California Edison's 2020-2022 wildfire mitigation plan replaces critical wood poles with composite or lightweight steel to be fire resistant [21]. Additionally, the average service lifetimes of steel and composite poles have been estimated at 80 years and concrete poles roughly 60 years [8, 16, 20]. Whereas the average lifetimes of wooden poles are generally estimated to be in the 30-50 year range, but there is wide variation in practice due to differences in inspection, maintenance, and replacement practices, which can extend lifetimes [17].

Table 1 presents information on the performance of various pole programs.

Table 1. Wooden pole program performance data

Utility (organization)	Investment Type	Period	Impact
Comparison of neighboring utilities impacted by same hurricane	Enhanced wood pole inspection		Inspection accuracy of 98% resulted in reduced post-hurricane pole replacements, peak outages, and restoration costs by factors of 18, 5, and 16, respectively compared to accuracy of 30%. [3]
Florida Power and Light	Enhanced wood pole inspection	Comparison of wood poles requiring replacement from Hurricane Wilma (Category 3, 2005) to Hurricane Irma (Category 4, 2017)	~75% reduction in number of wood poles requiring replacement after hurricanes. [5]
Duke Energy Florida	Wood vs steel transmission structures	Hurricane Irma (2017)	Duke Energy Florida had 27 wood transmission line poles fail compared to only 1 steel transmission tower fail [11].

Disadvantages

The primary disadvantages for replacing wood poles with non-wood material is that non-wood materials can be more difficult to repair and there is little quantitative information available on comparative costs relative to performance against extreme events [8]. For example, an EPRI study found that upgrading from Class 4 to Class 2[3] wooden poles could eliminate 90% of breakage at a cost increase of only 35% [7]. Whereas cost increases for non-wood materials can be 2-10 times more expensive, [8] (with composite being on the higher end of that range) but likely do not reduce breakage at the same rate. Ultimately, this means that utilities often use a wide range of pole materials and sizes depending on location and criticality of the poles because the cost-benefit tradeoff will vary[4] [8]. Additionally, many pole strengthening programs will include more than just replacement to balance cost and performance such as reducing span length by installing intermediate poles, installing additional guying, or strengthening a critical pole with steel trussing [8, 22].

Costs

Table 2 shows costs of several pole inspection, maintenance, and replacement programs. For reference, the standard cost for a 40 ft wooden utility pole (distribution) is typically under $1000, going up a class size on the distribution system is roughly $100 more per class [8, 20]. There are often wide ranges of reported costs which are typically due to differences in what programs entail (or how a utility does cost accounting), particularly the extent to which capital expenses – for repairs and/or replacements – are included.

[3] Wood pole “class” is a metric of strength in terms of horizontal load capacity, corresponding to minimum diameters at the tip and six feet from the butt or base. A lower-class number indicates greater strength.

[4] For example, in 2018 Tampa Electric Company had the following make up of distribution poles: 70% wood, 5% concrete, 1.5% aluminum, 2% Fiberglass (composite), <1% iron and steel, and ~20% “other” [24].

Table 2. Utility pole program costs

Utility (organization)	Investment Type	Period	Cost	Details
Duke Energy Florida	Transmission structure wood-to-steel replacement	2006-2020	$26k/ structure average (min. ~$10k in 2007, max. $61k in 2020); (2020 USD)	Replacement of wood transmission structures with steel (not differentiated between poles and towers) [8]
Florida Power & Light	Transmission structure wood-to-steel replacement	2007-2020	$26k/ structure average ($38k in 2006 - $256k in 2020); (2020 USD)	Replacement of wood transmission structures with steel (not differentiated between poles and towers) [8]
San Diego Gas and Electric	Transmission structure replacement with both steel and wood	2020	$27K/structure (2020 USD)	Average of a project that replaced 32 structures to correct clearance violations and structure overloads [23]
Duke Energy Florida	Distribution Lateral Hardening -Pole Inspection/Replacement	2023-2025	$10.8k/pole (nominal dollars averaged across years)	estimated cost includes treatment/reinforcement or replacement as needed [18]
Hawaii Electric	Mix of distribution and transmission poles in Critical Pole Hardening & Mitigation program	2022	$93.7K/pole (2022 USD)	Estimated cost includes replacing a critical pole with a stronger pole, reducing span length by installing intermediate poles, installing additional guying, or strengthening a critical pole with steel trussing.
DTE Energy (Michigan)	Distribution Pole and Pole Top Maintenance and Modernization	2021-2025	$37.5k/mile (nominal dollars averaged across years)	Estimated costs, includes inspection/repair, and 4.8kV hardening program[5] [4]

[5] 4.8kV program strengthens older distribution infrastructure in Detroit, in lieu of replacing the system.

Utility (organization)	Investment Type	Period	Cost	Details
Xcel Energy Minnesota	Distribution Pole Inspection/Replacement	2018-2020	$579/pole (nominal dollars averaged across years)	Above-ground visual and groundline visual, sound, and bore inspection as needed; treatment and or replacement as needed [19]
Florida Power & Light	Distribution Inspection	2023-2032	$361/inspection (nominal dollars averaged across years)	Estimated costs for Above-ground and excavation with sounding/boring; strength testing; determination of reinforcement or replacement [5]

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