NORTH AMERICAN WOOD POLE COUNCIL

No. 26-U-105

TECHNICAL BULLETIN

Burying the Grid

Heavy costs, limited benefits

Prepared by:

North American
Wood Pole Council

About NAWPC

The North American Wood Pole Council (NAWPC) is a federation comprising three organizations representing the North American wood preserving industry. These organizations provide a variety of services to support the use of preservative-treated wood poles to carry power and communications to consumers. **woodpoles.org**

Western Wood Preservers Institute
Headquartered in Vancouver, Wash., WWPI is a non-profit trade association founded in 1947. WWPI serves the interests of the preserved wood industry in 16 western states, Alberta, British Columbia and Mexico, working to ensure wood products exposed to the elements can maintain favorable use in aquatic, building, industrial and utility applications. WWPI works with federal, state and local agencies, as well as designers, architects, engineers, contractors, utilities and others across the entire preserved wood supply chain, so that these products continue to be produced and used in a safe, responsible and environmentally friendly manner. **wwpinstitute.org**

Southern Pressure Treaters Association
SPTA was chartered in New Orleans in 1954. Its members supply vital wood components for America's infrastructure, including pressure treated wood poles and wood crossarms, and the pressure treated timber piles which continue to be the mainstay of foundation systems for manufacturing plants, airports, commercial buildings, processing facilities, homes, piers, wharfs, bulkheads and simple boat docks. SPTA's membership is composed of producers of industrial treated wood products, suppliers of AWPA-approved industrial preservatives and preservative components, distributors, engineers, manufacturers, academia, inspection agencies and producers of untreated wood products. **spta.org**

Wood Preservation Canada
WPC is the industry association representing the treated wood industry in Canada. WPC operates under Federal Charter and serves as a forum for the individuals, companies, governmental agencies and other stakeholders involved with all phases of the pressure treated wood industry, to address topics such as research, production, handling, use and the environment. WPC is dedicated to promoting and supporting a stronger Canadian wood treating industry, informing the public of the benefits to be gained from the use of quality wood products, and preserving the integrity of the environment through responsible stewardship of our resources. **woodpreservation.ca**

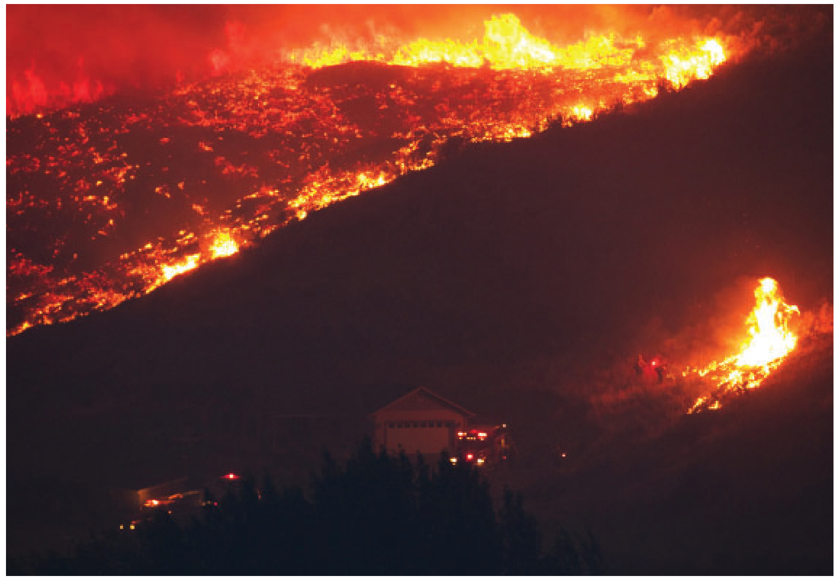
Burying the Grid: Heavy costs, limited benefits

Prepared by
North American Wood Pole Council

The debate is not new. The idea of converting overhead electrical distribution systems to underground has been studied extensively for at least the past quarter century. What is new is the weather events and wildfires which are re-igniting the debate are now more frequent and more severe.

In its *2025 Report Card for America's Infrastructure* the American Society of Civil Engineers (ASCE) states, "...infrastructure systems are increasingly vulnerable to natural disaster and extreme weather events… floods (are) more intense and occur more often, hurricanes create higher wind loads and wildfires encroach more unpredictably."[1]

As utilities, regulators and other stakeholders engage in a new generation of the same decades-old debate there now is ample research to inform the question of overhead vs. underground systems.



Growng liability and public outcry over damage from wildfires has renewed calls to underground electrical distribution lines, despite ample research suggesting the high costs outweigh benefits.

Undergrounding is expensive

Most everyone agrees that converting overhead electrical systems to underground is extremely expensive. In 2019 the California Public Utilities Commission (CPUC) put the cost of conversion at $1.85 million to $6.1 million per mile.[2] That would be $2.35 million to $7.73 million in 2025 dollars.

For context, the CPUC says undergrounding is up to 10 times more expensive than installing new overhead lines, not accounting for variables such as building density, labor costs, terrain and geology, which drive costs even higher. A separate study citing multiple sources notes undergrounding is 5-15 times more expensive.[3]

The time it takes to move lines underground must also be considered. In 2021, an investor-owned utility in California announced plans to underground 10,000 miles of overhead distribution lines within 10 years, mostly at ratepayer expense. The utility had successfully undergrounded 73 miles of distribution lines the previous year. At that rate, converting 10,000 miles would take more than 100 years. Accomplishing the 10-year goal would require the conversion rate to become nearly 17 times faster virtually overnight. Even then, success would mean less than 10 percent of the utility's California distribution lines would be converted.[4]

An Edison Electric Institute (EEI) report[5] published in 2009 refers to eight state-sponsored studies commissioned in response to major storms between 2002 and 2008. The first of those, *The Feasibility of Placing Electric Distribution Facilities Underground,*[6] was prepared for North Carolina's Natural Disaster Preparedness Task Force. Its scope was limited to three investor-owned utilities and it focused on distribution lines only.

Among its conclusions: "…replacing the existing overhead distribution lines with underground lines would be prohibitively expensive. Such an undertaking would cost approximately $41 billion, nearly six times the net book value of the utilities' current distribution assets, and would require approximately 25 years to complete." In 2025 dollars, that cost would be $72.2 billion.

Costs outweigh benefits

In 2021 New York commissioned a study[7] of the feasibility and costs of burying all or most of the state's electric and telecom lines. Completed in 2023, it concluded, "The costs of undergrounding … would substantially exceed the associated benefits. The study estimates the present value of the net loss in social welfare at $261 billion (2023 dollars)."

A 2007 report[8] based on a literature review of 61 references compiled by InfraSource Technology, states, "This review finds that the conversion of overhead electric distribution systems to underground is costly, and those costs are far in excess of quantifiable benefits presented in existing studies…"

What could go wrong?

Ironically, much of the discussion around moving distribution lines underground has been prompted by severe weather events such as hurricanes. Yet those same events unleash perhaps greater threats to underground systems. Hurricane winds cause significant damage, but the biggest threat comes from water. Storm surges are known to have demolished pad-mounted equipment and to have filled underground vaults with sand. Receding storm surges strip away topsoil, exposing equipment that previously had been underground.[9]

Houston's below grade electric vaults were praised in 2008 for helping to keep the lights on after Hurricane Ike hammered the Texas gulf coast.[9] But in 2017 heavy rains associated with Hurricane Harvey flooded the vaults, leaving more than 80 downtown buildings without power. Some of the city's performing arts venues went weeks without the ability to operate normally.[9]

Infamous for filling the New York City subway system with some 600 million gallons of seawater in 2012, Hurricane Sandy's storm surge and heavy rains also flooded a Con Edison underground substation.[9] This left 220,000 customers without power for several days while crews worked to pump the water out and replace equipment damaged by the salt.[9] According to *Forbes* the restoration cost more than $561 million ($790 million in 2025 dollars).

Flooding caused by Hurricane Sandy inundated not only the NYC subway system, but also Con Edison's underground electrical substations, leaving at least 220,000 customers without power for an extended period. The substation repair bill exceeded $561 million ($790 million in 2025 dollars).

Determining reliability

A common perception is underground systems are more reliable than overhead systems. However, according to the InfraSource report, that perception is oversimplified.[8]

The report states that repairs in underground systems typically take at least twice as long as repairing overhead lines. Locating the source of the fault underground might require specialized equipment and reaching it to make repairs often requires excavation, adding significantly to the repair time.

Underground systems are not impervious to threats from fire. Above ground pad-mounted equipment is needed where the electrical current is transferred to or from the buried distribution lines. These transformers remain susceptible to damage from fire and could also be a source of ignition.

Underground systems face q risk of damage from everyday events as well. The Common Ground Alliance reports that in 2024 there were nearly 200,000 incidents of excavation-related damage, or "dig-ins," to buried utility systems of all types, a 4 percent increase from the previous year.[10]

Regional reports suggest as many as 15 percent to 20 percent of those involve underground electrical systems. A brief[11] prepared in 2024 for the Minnesota state legislature notes from 2020 to 2022, 17.4 percent of that state's dig-ins affected underground electrical systems. These incidents pose a safety risk and most result in power outages.

Using five years of reliability data, a North Carolina utility found underground systems had 50 percent fewer outages than overhead systems, but the duration of outages averaged 58 percent longer.[12]

The North Carolina study did not quantify how widespread the outages were, but because of how the systems are built, underground faults commonly affect much wider geographic areas. In addition to cost differences, utilities must weigh the pros and cons of more interruptions of significantly shorter time periods affecting fewer customers vs. fewer outages that last much longer and affect more customers.

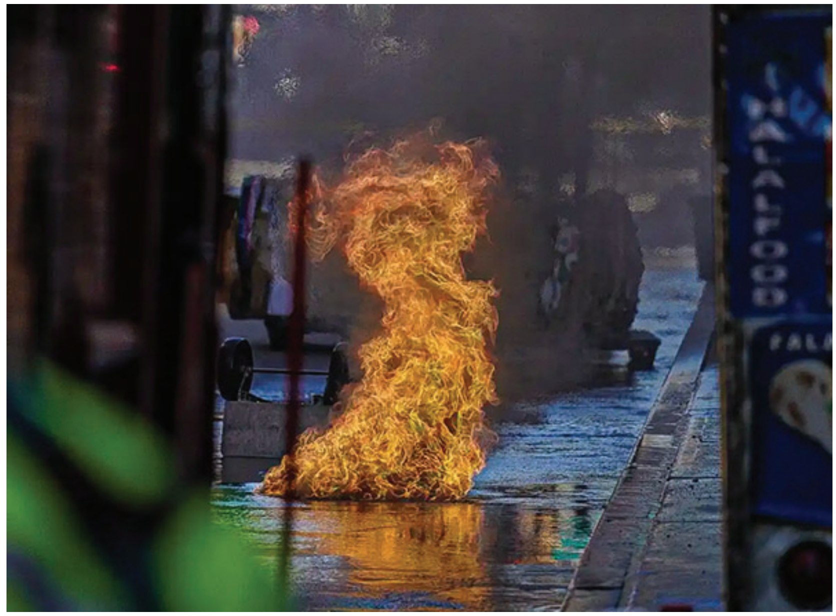
Service life questions

Direct comparison of the useful service lives of underground systems vs. overhead systems is difficult. When large-scale undergrounding first became widespread some 65 years ago, systems had expected service lives of 30-35 years. The InfraSource report, produced in 2007, states overhead facilities last roughly 60 percent longer than equivalent underground equipment and that over time, utilities can expect to replace underground equipment at nearly twice the rate as overhead equipment.[8]

With technology advancements in cable, vault design and monitoring equipment underground systems now have projected service lives in the 50-70 year range.[13] Those projections compare more favorably with what experience has proven to be the case for overhead systems, but the empirical evidence to support the projections remains to be seen.

For overhead systems, "end of service life" often means there is a need to replace a small number of poles, not an entire circuit. This results in shorter, more localized disruptions. With rigorous inspection and maintenance programs, overhead systems have potentially unlimited service life — individual components can be replaced as needed, but the system as a whole remains intact.

Underground systems are not conducive to regular inspection and maintenance. Utilities instead use electronic diagnostic tools to assess a line's condition and estimate its remaining useful life. This data is then used to plan replacement schedules the utilities hope will maximize in-service time while avoiding circuit failures. When the time comes, entire circuits must be replaced, resulting in extended service interruptions which must be mitigated somehow, often by erecting temporary overhead systems.



Caused when highly flammable gases accumulate in underground vaults and are ignited by sparks from an arc, "manhole events" include explosions powerful enough to blast manhole covers several stories into the air. Nearly all such events are associated with buried electrical systems. To view a short video of a few very-near misses visit https://bit.ly/manhole_events.

Safety concerns

Placing electrical distribution lines underground carries its own unique set of safety concerns. As electricity runs through a conductor, some of the energy is converted to heat. In overhead systems that heat dissipates as it is created; the lines are "air-cooled" in a sense. Because underground systems are enclosed, the heat is trapped and can increase to unsafe levels if not properly addressed.

The number and size of the cables impact how much energy is dissipated. Underground systems require more cable that is larger in diameter, resulting in greater energy dissipation. They are less efficient than overhead— more electricity must be generated in order to deliver the same amount of power to the end-user.

Faults in overhead systems are relatively easy to locate and address. Underground systems, however, are hidden, making faults much more difficult to detect, particularly if they do not cause an outage. Fault repair requires excavation or vault access. Line workers cannot see what they are dealing with until they enter the space, exposing them to greater shock risk and other dangers.

According to IEEE, electrical systems are associated with virtually all significant "manhole events" – smoke, fires or explosions in underground structures. Some 95 percent of these involve low voltage wire, such as that used to bring electricity to individual homes via buried conduit.[14]

Manhole events can occur when conductor insulation wears out or is damaged. The insulation and other organic matter in the vault decompose, releasing flammable gases including carbon monoxide, hydrogen and methane. Shorts that sometimes are too small for fault testing equipment to detect generate heat that causes the wire insulation to smolder, accelerating the decomposition process.[15]

The trapped gases accumulate and are ignited by electrical arcs from wires frayed due to aging, overload, corrosive chemicals or rodents chewing on them. The result can be explosions powerful enough to blast heavy manhole covers several stories into the air, an obvious risk to anyone or anything that happens to be nearby at the time.

Currently less than 20 percent of distribution lines and 5 percent of transmission lines are underground. Even with such a small percentage of the grid buried, concern about these safety hazards is high, as evidenced by IEEE forming the P2417 Working Group on Manhole Events to address how to mitigate them. Stuart Hanebuth, vice chair of that working group, estimates between 1 million and 2 million underground structures exist today. Based on reporting by utilities and the media, he calculates 3,000 to 5,000 serious manhole events occur each year.[16] As pressure mounts to move much larger portions of the system underground, the level of those concern grows proportionately.

What are the options?

Only about 3 percent of all wildfires are grid-caused,[17] yet in recent years the focus on fires sparked by overhead electrical distribution systems has been magnified. The public outcry and liability associated with damage from these wildfires is driving new calls to underground lines, forcing utilities to take action.

Many alternatives to undergrounding can be implemented more quickly at far less cost. None by themselves can be considered a panacea, but when combined these alternatives can achieve similar levels of wildfire risk reduction at lower cost without introducing potential new issues that come with burying distribution lines.

Operational strategies

Unpopular for disrupting customers' daily activities, Public Safety Power Shutoffs (PSPS) remain one of the most effective wildfire mitigation strategies, according to the North American Electric Reliability Corporation (NERC), a regulatory authority that sets and enforces reliability standards for the bulk energy system.[18] The hard cost of a PSPS is virtually zero, though it does have negative impacts including lost revenue to the utility and inconvenience to the customers affected. However, disruptions caused by a PSPS appear minor when compared with the costs and reliability issues associated with undergrounding or the damages caused by wildfire.

Vegetation management, inspections

Several grid-caused wildfires, including California's Camp Fire in 2018, the Dixie Fire in 2021 and L.A. County's Eaton Fire in January 2025, could have been prevented simply with rigorous inspection programs, more frequent maintenance and vigilant vegetation management.[17] In its investigation report surrounding the Dixie Fire, the California Department of Forestry and Fire Protection (CAL FIRE) stated the fire started when a 65-foot tall damaged and decayed Douglas fir tree fell onto adjacent power lines. The investigation concluded the tree's damage and decay "would have been noticeable at the ground level by inspectors pre fire without extraordinary effort."

A more aggressive overhead asset inspection and maintenance program may have prevented that fire. CAL FIRE found the utility to be in violation of multiple state reguations governing inspection and maintenance of overhead distribution systems.

Grid-caused wildfires start when surrounding vegetation, dead or alive, comes in contact with live wires. Increasing line inspection frequency, avoiding deferred maintenance and prioritizing prompt hazard tree removal and vegetation management drastically reduces the likelihood of that happening.

Equipment upgrades, modernization

Replacing bare cables with tree wire or fully insulated conductors greatly reduces the likelihood of ignition when live wires do come in contact with surrounding flammable material. Fully insulated wires are required for buried lines. The CPUC says undergrounding is at least eight times more expensive than installing insulated conductors in place of bare wires. Incorporating insulated wires has been cited by many as a more cost-efficient and nearly equally effective option.

The past few decades have brought significant technological advancements to help prevent outages and grid-caused wildfires, improve response times and/or minimize damages. Among them:

- AI-driven aerial inspections using drones
- Automatic sectionalizing fuses and reclosers to isolate damaged line sections and limit ignitions and the extent of outages. These devices improve supply continuity and service restoration times while reducing the number of crew-hours required for repairs according to an internal study by Con Edison.
- Smart-Grid technologies such as real time data sensors, sag monitoring devices and AI-based instant arc detection with fast protection relaying to rapidly detect and pinpoint faults.
- AI-enabled cameras can detect fires early, so suppression efforts can begin before the fire gets out of control.
- Real time weather and wind monitors to detect conditions conducive to wildfire and provide faster more accurate storm tracking, allowing for pre-emptive mitigation measures such as public safety power shutoffs.
- Remote-controlled sectionalizing devices isolate affected portions of circuits so fewer customers will be impacted by pre-emptive measures. From 2020 to 2022 Southern California, Edison detected 90 incidents of wind-related damage that could have caused ignition but didn't because it was able to isolate the affected portions of circuits and de-energize them, removing the ignition threat. Knowing that only a limited number of customers would be affected, the utility was able to act without hesitation.

More detail around these strategies and others can be found in Sandia's *Systemic Drivers of Electric-Grid-Caused Catastrophic Wildfires: Implications for Resilience in the United States* and in NERC's *July 2025 Wildfire Mitigation Reference Guide*. The NERC publication also describes the latest R&D projects to improve these technologies and offers dozens of links for more information, including a number of utilities' current Wildfire Mitigation Plans.

Wood poles wrapped with intumescent remain standing amid rubble left by the Palisades Fire. When disaster strikes, power must be restored before other restoration efforts can begin in earnest. Not having to install new poles accelerates the process.

Hardening existing overhead assets

New technologies to protect existing wood infrastructure have been proven effective, both in the lab and in actual wildfires. Chief among these are pole wraps, intumescent-coated wire or fiberglass mesh that can be applied to existing and new wood poles to keep them from becoming a fuel source or failing due to fire damage.

When activated by the approaching heat of a wildfire the intumescent expands to form an inflammable layer of protection that prevents wood poles from burning. Pole wraps can withstand extreme weather and they allow lineworkers to climb wood poles with standard climbing gear. Most pole producers offer wraps as a value-add, pre-installed on new poles as well.

Prior to passing the scrutiny of CAL FIRE in controlled field tests conducted in 2022, pole wraps had already proven their effectiveness when several mesh-wrapped poles took direct hits during 2020's Lake Fire. Southern California Edison inspectors who examined the affected poles said they "were undamaged and retained the color and look of poles that had not gone through a wildfire."

Further testing showed the poles retained their full strength after the fire, prompting the utility to declare fire mesh "an effective means of protecting wood poles in a wildfire."[4] More information is available at woodpoles.org.

Environmental impacts of undergrounding

In 2008 Southern California Edison (SCE) commissioned a Life Cycle Assessment (LCA) comparing the environmental impacts of underground and overhead distribution systems. The study was completed in 2009 by a team of researchers at University of California, Irvine.[19]

The LCA found "The underground system has more environmental impact potential than the overhead system in all categories and most scenarios." The differences were substantial in several of the categories, including global warming potential, abiotic depletion potential and acidification potential. The LCA authors determined cable production was the largest contributor to the overall environmental impacts. The system that uses more cable (undergrounding) has the greater environmental impact potential. The need to use substantially more and larger cable for undergrounding also is a big contributor to the vast cost difference between overhead distribution and undergrounding.

Other LCA work[20] clearly shows that wood utility poles supporting overhead systems have the least environmental impact compared to other materials such as steel, concrete or fiberglass composites.

Conclusion

When downed power lines result in outages or worse, inevitably someone asks in frustration, "Why don't we just bury those things?!"

The question has at least six good answers:

- Undergrounding is far more expensive and takes a very long time to complete
- Undergrounding may result in fewer outages, but the outages typically last much longer and affect far more people
- Undergrounding introduces new risks and safety issues
- Other far less costly options can be nearly equally effective in reducing wildfire risk
- Wood poles can be protected from burning by using intumescent mesh wraps
- Undergrounding has a much higher environmental impact potential than overhead distribution

References

1. *A Comprehensive Assessment of America's Infrastructure 2025.* American Society of Civil Engineers 2025

2. *CPUC Undergrounding Programs Description.* California Public Utilities Commission website 2026. www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/electric-reliability/undergrounding-program-description

3. *Front-Line Resilence Perspectives: The Electric Grid*. Argonne National Laboratory, Global Security Sciences Division 2016

4. *Proceedings, General Rate Case A21-06-021*. The Public Advocates Office, California 2022

5. *Out of Sight, Out of Mind Revisited: An Updated Study on the Undergrounding of Overhead Power Lines*. Edison Electric Institute, Kenneth Hall, P.E., Hall Energy Consulting 2009

6. *The Feasibility of Placing Electric Distribution Facilities Underground.* Report of the Staff to the North Carolina Natural Disaster Preparedness Task Force 2003

7. *The Benefits, Costs, and Economic Impacts of Undergrounding New York's Electric Grid*. Industrial Economic Incorporated 2023

8. *Undergrounding Assessment Phase 1 Final Report: Literature Review of Electric Distribution Overhead to Underground Conversion*. Richard Brown, PhD, PE, InfraSource Technology 2007

9. *Multiple sources including EE Times, Centerpointe Energy, Time magazine, Houston Chronicle, New York Times, and Forbes.*

10. *DIRT Report 2024 Analysis and Recommendations*. Common Ground Alliance 2025

11. *Digging into Danger: Broadband Installation Damage in Minnesota*. NorthStar Policy Action 2024

12. *Enhancing Distribution Resiliency, Opportunities for Applying Innovative Technologies*. Electrical Power Research Institute (EPRI) 2013

13. *Practical Approach to Underground Distribution Power Cable Fleet Management.* Energies 2023

14. *Understanding Manhole Events.* Stuart Hanebuth, Vice Chair, IEEE P2417 Working Group on Manhole Events 2022

15. *Preventing and Mitigating Manhole Events.* IEEE White Paper prepared by IEEE Insulated Conductors Committee 2015

16. *Understanding and Mitigating Manhole Explosions: An Interview with Stuart Hanebuth*. Polywater blog undated

17. *Systemic Drivers of Electric-Grid-Caused Catastrophic Wildfires: Implications for Resilience in the United States*. Holly Eagleston, Michelle Bester, Jubair Yusuf, Adit Damodaran and Matthew J. Reno, Sandia National Laboratory 2025

18. *Wildfire Reference Mitigation Guide*. North American Electric Reliability Corporation (NERC) 2025

19. *Life Cycle Assessment (LCA) of overhead versus underground primary power distribution systems in Southern California*. Sarah Bumby, Katya Druzhinina, Rebe Feraldi and Danae Werthmann, Donald Bren School of Information and Computer Sciences, Univ of Calif, Irvine

20. *Environmental Life Cycle Assessment of Chromated Copper Arsenate-Treated Utility Poles with Comparisons to Concrete, Galvanized Steel, and Fiber-Reinforced Composite Utility Poles* and *Life Cycle Assessment of pentachlorophenol-treated wooden utility poles with comparisons to steel and concrete utility poles.* Christopher A. Bolin and Stephen T. Smith, 2022 and 2025

NORTH AMERICAN WOOD POLE COUNCIL