NORTH AMERICAN WOOD POLE COUNCIL

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Undergrounding: Hidden Lines, Hidden Costs

Prepared by:

North American Wood Pole Council

About NAWPC

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

The three organization are:

Western Wood Preservers Institute
With headquarters in Vancouver, Wash., WWPI is a non-profit trade association founded in 1953. WWPI serves the interests of the preserved wood industry in the 17 western states, Alberta, British Columbia and Mexico so that renewable resources exposed to the elements can maintain favorable use in aquatic, building, commercial and utility applications. WWPI works with federal, state and local agencies, as well as designers, contractors, utilities and other users over the entire preserved wood life cycle, ensuring that these products are used in a safe, responsible and environmentally friendly manner.

Southern Pressure Treaters' Association
SPTA was chartered in New Orleans in 1954 and its members supply vital wood components for America's infrastructure. These include pressure treated wood poles and wood crossarms, and 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 or simple boat docks. The membership of SPTA 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.

Wood Preservation Canada
WPC is the industry association that represents the treated wood industry in Canada. WPC operates under Federal Charter and serves as a forum for those concerned with all phases of the pressure treated wood industry, including research, production, handling, use and the environment. WPC is dedicated to promoting and supporting a stronger Canadian wood treating industry; informing the public on the benefits to be gained from the use of quality wood products; and preserving the integrity of the environment through the promotion of responsible stewardship of our resources.

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Introduction

American's reliance on electricity has grown significantly in the age of smartphones, computers and an increase in assisted living centers. Disruptions in electric service from storms, ice and other weather events often prompt calls to move power lines underground to make service more reliable.

Additionally, removal of poles and overhead lines is considered to improve the aesthetics of a neighborhood or area.

Placing electrical lines underground may, on the surface, seem like an easy task. The reality of going underground is much more complicated – and considerably more expensive to the public.

When compared to overhead power systems, it's clear that putting electrical lines underground is vastly expensive, susceptible to lengthy outages and potentially unsafe while providing only modest improvements in reliability.

Costs of Undergrounding

Over the years, utilities and state agencies throughout the U.S. have done numerous studies on putting power lines underground. The vast majority of these studies conclude that undergrounding is far more expensive than overhead systems, requiring billions of dollars from utility customers and taxpayers.

These studies typically follow a major natural disaster, such as a hurricane or storm. Recent studies by states and communities have confirmed what earlier research found when considering undergrounding:

2010 Public Service Commission, District of Columbia

- Cost of undergrounding existing lines: $5.8 billion
- Reduction of outages: 1,030 fewer per year

2009 Mayor's Task Force, Electric Service Reliability, Houston, Texas

- Cost of undergrounding existing lines: $35 billion
- "Undergrounding has other costs in traffic congestions and business losses as rights-of-way are excavated."
- During Hurricane Ike, fewer than 1 percent of the system's 1 million poles were knocked out of commission, "suggesting that improved vegetation management will have a more significant effect on reliability."

2005 State Corporate Commission, Virginia

- Cost of undergrounding existing lines: $80 billion
- Annual cost increase to each electric customer: $3,000+

Conversion of overhead lines to underground is much more expensive than new installations. However, overall growth rate for new overhead or underground facilities is less than 1 percent per year. So any activities promoted as hardening the system through undergrounding is targeted at moving existing overhead line at a very high cost.

Costs comparison, overhead vs. underground

Research by the Edison Electric Institute (EEI), an independent organization funded by investor-owned utilities, shows the cost difference per mile of building overhead vs. underground is significant, with undergrounding costing as much as 10 times that of an overhead line.

For new overhead lines, construction costs range from $86,700 per mile for rural areas up to $1 million for urban areas. Cost estimates for underground lines range from $297,200 per mile in rural areas up to $4.5 million per mile for urban construction.

New Construction, Distribution - Cost Per Mile

	Overhead System			Underground System		
	Urban	***Suburban***	***Rural***	***Urban***	***Suburban***	***Rural***
Minimum	$126,900	$110,800	$86,700	$1,141,300	$528,000	$297,200
Maximum	$1,000,000	$908,000	$903,000	$4,500,000	$2,300,000	$1,840,000

Table 1 - *New construction costs for underground distribution systems trend significantly higher compared to overhead distribution, where wood poles are most lilkely to be used. The variation between urban and rural is related to the need for a greater number of poles or manholes, transformers and service drops per mile.* Source: *Out of Sight, Out of Mind 2012, Edison Electric Institute*

Converting existing overhead lines to underground is even more expensive. Placing an existing overhead line in an urban area underground could cost as much as $20 million an mile. In rural areas, that cost could top almost $2 million a mile.

Other Costs for Undergrounding

There are other factors that drive up the costs of putting power lines underground. The cable itself is far different – and more expensive – than what is used in overhead systems.

Lines placed underground face more risks from deterioration and thus must have more sheathing, insulation and protective coatings. These cables are three to four times larger than cables attached to overhead poles.

Heat builds up as electricity moves through the lines, which also increases the electrical resistance affecting the efficiency of moving electricity through the line. Depending on voltage, most underground designs require cooling equipment. Inadequate cooling can lead to overheating of the lines which can lead to a failure in the circuit.

This is a maintenance concern that becomes more critical as voltage and line lengths increase. By comparison, overhead lines are cooled by the air naturally.

The demanding conditions found underground does impact the life expectancy of cables and lines. It is estimated the life expectancy of an underground line is about half that of an overhead line. Utilities who placed cables underground in the 1970s and ‘80s have discovered much higher failure rates in such lines, requiring replacement.

Digging a trench for underground lines can be problematic is areas with rocky soils or those experiencing deep ground freezing, increasing labor costs. Routing lines under existing roads, highways or rivers also require specialized equipment, further raising costs.

After an overhead line is moved underground, there are even more costs that must be paid directly by electrical customers. Changing an overhead service to underground may involve moving or installing a new meter, requiring homeowners to hire an electrician to do the work.

Trenching from the utility service to the home may also be required, with the costs paid by the homeowner, not the utility.

Recovering Costs

When utility lines are placed underground, the cost is paid by the utility ratepayers themselves. Typically, this is paid by higher utility rates that can extend for decades.

Studies on undergrounding proposals in North Carolina and Florida suggested that placing lines underground would require rate increases of 80 percent to 125 percent annually. Virginia calculated the annual cost of undergrounding lines statewide would equal about $3,000 per customer.

These higher rates are not one-time, single year charges. To make them more affordable, these higher rates are planned to extend for a quarter century or more.

The City of Anaheim in 1990 voted to underground its entire electrical system. The project is expected to take more than 50 years and it will be funded by a 4 percent surcharge on every electric bill, collected for the duration of the project.

Given the billions of dollars that are needed, utilities and communities are increasingly asking government and taxpayers to aid in subsidizing undergrounding work. Some have even turned to the Federal Emergency Management Agency (FEMA) and the Department of Homeland Security to secure funds for "hardening" electrical systems by placing them underground.

As a long-term investment, though, the returns are less than impressive. Virginia calculated the benefits of an underground system would offset only about 38 percent of the total costs.

Australia, in one of the most extensive studies of transitioning to an underground system, concluded the benefits of undergrounding would offset as little as 11 percent of the costs.

Reliability Improvements

In overhead systems, service disruptions are typically caused by storms where trees or limbs fall across lines. Obviously, underground systems do not have the same risk from external debris. That fact, however, does not make underground lines more reliable.

Government electrical system reliability statistics were analyzed by EEI from 2004-2011. The analysis determined customers with underground service experienced a lower frequency and fewer minutes of service interruption.

However, EEI's analysis cautioned that underground and overhead elements of an electrical system are not independent of each other. Most underground facilities are served by an overhead feeder. EEI concluded that "it is not conclusive if underground customers consistently experience a higher level of system reliability from a national average perspective.

In 2004, Florida Power & Light reported that upward of 98 percent of its customers in Broward County lost power after Hurricane Wilma. This occurred despite the fact that 54 percent of those customers were served by underground service.

Water problems

While storms are the chief cause of electric disruptions, they are often accompanied by flooding as a result of torrential rains. Underground systems are more susceptible to damage from floodwaters, particularly at underground vaults and transformer facilities.

Salt water is particularly harmful to underground electrical systems. Hurricanes are often accompanied by strong storm surges, raising sea levels significantly in coastal locations.

This flooding can fill electrical vaults with corrosive salt water that can cause future issues for electrical components.

Underground lines in New Orleans after Hurricane Katrina and in the northeast after Superstorm Sandy were damaged by salt water from the storm surge flooding.

Even after the flooding has subsided, pumping the water out of these underground structures can be problematic if oil from transformers or other chemicals have mixed in the water.

In flooding, overhead systems face risks if strong currents transport debris against poles. In most cases, wood poles have few lasting impacts from being exposed to floodwaters.

Repairs to Electricity Systems

All electricity delivery systems deteriorate over time, from weather events, accidents or just age.

Figure 1 - *Moving overhead lines underground is not only expensive, but creates significant disruptions in the areas where such work is done. Most undergrounding conversion projects require cutting through concrete or asphalt, forcing detours for traffic and pedestrians. Excavating also may be necessary to make repairs in underground systems should there be power failures.*

In repairing these systems, there are many more advantages for overhead systems.

Utilities today have assets, procedures and trained personnel in place to respond to electrical disruptions when they happen and return service to customers quickly.

Outages caused by downed lines or poles are relatively easy to locate. The needed materials to make repairs are simple to determine and most utilities have a readily accessible inventory of spare materials.

Underground lines are much more difficult to diagnose problems and make repairs. Once the issue is found, it is also more expensive to make repairs as excavating equipment and specialized technicians may be needed.

Making such repairs also takes more time than in overhead systems. North Carolina utilities noted between 1998 and 2002, outages for underground systems were 50 percent less than those for overhead lines. However, the average duration for an underground outage was 58 percent longer.

The benefits of making regular inspections on overhead systems are widely recognized within the utility industry. Visual inspections of poles and lines can identify potential future problems and allow utilities to conduct proactive repairs before there is a failure.

Aging of electricity delivery systems is another important consideration. Research done by Oregon State University indicates preservative-treated wood poles can provide service for 50 years or more. Some poles identified in the research have been in place for up to 80 years.

The service life of cable is far less. The Maryland Public Service Commission in 2000 determined from state utilities that underground cables reach their end of life after 25 to 35 years and may become unreliable after 15-20 years.

Manufacturers claim newer cables protected with other materials have a much longer service life. However, unlike overhead systems that have been in place for more than a century, there are no long-term service records for these cables.

Dangers of Undergrounding

While underground cables may be hidden from sight, they still can pose dangers to utility workers and the public. These dangers include explosions of underground facilities, structural failures of underground vaults and potential injury from striking an underground line during excavating work.

Figure 1 - *Unlike underground systems, most repairs to electrical service can be done by lineman who have the appropriate gear to restore service quickly and economically.*

The Common Ground Alliance, in its annual DIRT Report, recorded nearly 290,000 events in 2015 of damage to electrical, natural gas and other underground services caused by excavation. This represented an increase of nearly 75,000 over the previous year, reflecting higher construction activity in the country.

Explosions and fires in underground electric facilities are perhaps the most visible reminder of potential dangers. Underground vaults, typically found in urban areas, can accumulate volatile gasses which can be ignited by the heat or sparks from electrical equipment.

Video footage of these explosions can be found easily on the web. Recent incidents include a transformer explosion in May 2016 in St. Petersburg, Fla., that engulfed firefighters on the scene. Fortunately no one was hurt, but thick, black clouds of smoke filled the downtown area for hours and it took days to bring power back on line.

Similar explosions and fires were reported in Phoenix and Los Angeles, impacting tens of thousands of customers who lost power for days.

The utility industry recognizes these incidents as "manhole events." A white paper prepared for the Institute of Electrical and Electronics Engineers (IEEE) notes there are hundreds of manhole events reported in North American each year.

The paper states: "Manhole events appear to be increasing as electrical equipment ages and as the extent of underground installations of transmission and distribution networks increase, particularly in highly-populated, congested urban settings."

The aging of underground vaults is a potential source of danger as well. A Southern California utility reports that for every 10 underground electrical vaults it inspects, six require repairs.

Aging vaults of top concern are those located under streets or sidewalks, where the structural frame requires shoring up to bear the weight of vehicles and pedestrians.

Environmental Impacts of Undergrounding

Wood utility poles have the least impact on the environment compared to other materials such as steel, concrete or fiberglass composites. That is also true when it comes to undergrounding lines.

A Life Cycle Assessment (LCA) of overhead vs. underground systems in Southern California was conducted by the University of California, Santa Barbara in 2009. The LCA compared the environmental impacts of both systems on a cradle-to-grave basis.

The study reviewed all aspects of each system, including production of materials, energy use, emissions and end-of-life management. The LCA concludes: "The underground system has high environmental impact potential than the overhead system in all categories in virtually all scenarios."

Summary

The trend of utilities placing electric services underground in new, greenfield projects is expected to continue in the future. These decisions are intended to meet customer demands on aesthetics, particularly in residential areas, and are easier to fund through connection and other fees.

At the same time, the growth in new projects requiring distribution or transmission lines – both overhead and underground – is anticipated to grow by less than 1 percent a year.

Converting existing overhead lines to underground, by nearly all measures, is prohibitively expensive and generates modest benefits, at best, in reliability and system longevity. Utilities and their customers will find greater benefits in proactively maintaining and repairing overhead systems.

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