WHITE PAPER

The Logical Place for Long-Haul Fiber Is Underground

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Electric utilities seeking to increase their fiber connectivity have historically looked up, installing optical ground wire (OPGW) overhead in their transmission rights-of-way (ROWs). Given the capacity limits, load analysis, environmental exposure and long-term maintenance requirements of installing fiber cables aerially, some utilities are rethinking that approach. Newer tools make it possible to install fiber rapidly underground in the same ROWs, opening doors to new revenue streams and satisfying increased demand for telecommunication networks.

Rising demand for bandwidth, a growing focus on broadband and closing the digital divide, and reevaluation of electric utilities' mission are challenging some long-held planning assumptions and changing the way a growing number of utilities approach fiber-optic installations.

More than two decades have passed since fiber optics made the copper cabling used in utilities' T-1 circuits for data transmission obsolete. Since then, optical ground wire (OPGW) has become the power industry's medium of choice for long-distance wired data transmission.

Installed on overhead transmission lines, OPGW not only contained the optical fibers needed to transmit communications data but also provided the grounding needed to protect high-voltage phase wire on a tower from lightning strikes. With routes already in place, transmission ROWs offered the shortest path between locations to be connected.

Over time, however, changing market needs began to reveal the limitations of OPGW. For example, fiber counts of greater than 72 or 96 strands were rare in early versions of OPGW. The recent deployment of 5G, the drive to 6G wireless networks, and the expansion of broadband into unserved and underserved areas are among the converging trends now driving demand for cables with much higher strand counts.

In addition, utilities' need for supervisory control and data acquisition (SCADA) connections to control both the grid and their own internal systems continues to grow. So does the number of utilities creating subsidiaries that operate as internet service providers (ISPs) or partnering with other carriers to create new, non-energy-related revenue streams.

Meanwhile, OPGW replacement costs skyrocketed. The time and expense of outages, the need to upgrade structures to accommodate heavier cables, and the maintenance costs associated with storm damage and other environmental exposure all point to the same conclusion: OPGW might not have the flexibility and resiliency utilities require to meet their long-term fiber connectivity needs.

What Went Up Should Now Go Down

To provide a pathway for large-scale access to broadband internet service, the optimal place to deploy the next generation of fiber is underground along transmission and distribution ROWs. There are many reasons for this.

Underground transmission ROWs follow the same direct path as OPGW. Transmission ROWs have already established a route for the fiber cable, whether it is placed in the ground wire or underground. The ROWs usually represent the most direct routes between substations and local offices in cities and towns — the critical connection points utilities use to manage the grid.

While urban transmission routes often follow public ROWs, a majority of transmission routes are in suburban and rural areas that utilities can access easily and more exclusively. These routes also tend to be direct, reducing the route distance and resulting in lower material and labor costs and shorter installation time.

In many states, utilities have a legal right to use these underground ROWs for fiber placement. In others, installing communication cable may require renegotiating easement agreements with individual landowners. These negotiations and their associated costs, however, rarely impact the revenue enhancement achieved when fiber is placed underground along the ROW. Whenever modifying or developing new easement agreements, it is prudent to add explicit rights for underground fiber and communications reselling. This should be done even if the state currently doesn't require it, as changes in politics can modify a state's future legal stance on these rights.

Access to the transmission path is often limited. Limiting the fiber cabling's exposure is critical to maintaining service and minimizing maintenance costs and down time. That can be accomplished when ducts and cable are installed underground, especially in rural and many suburban areas, where typically only the utility and the landowner have access to the transmission path. Access control can be more difficult to manage in urban areas, where other utilities, state and county Departments of Transportation (DOT), or their contractors often work along public ROWs.

Fiber can be made more accessible. Accessing OPGW has long been an issue for potential leasers of a utility's dark fiber. Migrating the fiber from up on a transmission tower — where a primary utility process is to go as far as possible before reaching another splice/access point to reduce the ongoing maintenance and reliability of the fiber — to underground — where you can add more strategic splice/access locations that can be advantageous for potential leasers and avoids the need to access the fiber solely within a substation — is an logical strategy. Making the fiber more accessible will lead to more leasers wanting to utilize utility-owned fiber because they will now be able to access it closer to where their networks are deployed.

Permitting can be easier. Placing fiber cabling along an existing transmission ROW raises fewer permitting issues than installing it in a public ROW. Public ROWs not only require extra DOT, city and county permits, but also demand electric utilities coordinate their efforts with other buried utilities. When using public ROWs, the risk of one party mistakenly digging up another's cable increases.

By comparison, the transmission ROW in suburban and rural areas is rarely shared with other utilities. Only DOT, railroad and wetland permits are routinely required to bury fiber along this ROW.

State and county DOTs typically require permits for highway crossings. Railroad permits are usually easier to obtain when the encroachment to the railroad ROW is limited to a perpendicular crossing, rather than running parallel to railroad tracks.

Wetlands and waterways near a route can sometimes pose permitting challenges. Wetlands, as defined by the U.S. Environmental Protection Agency and U.S. Army Corps of Engineers, include "areas where the frequent or prolonged presence of water at or near the soil surface drives the natural system." Swamps, marshes and bogs all fall within this definition. While permits are not required for underground fiber in most wetlands, rules govern drill placement when boring beneath them.

Waterways permitting varies, with each state determining which lakes and rivers within its borders are regulated. Permitting requirements also vary. For example, some permits dictate the distance required between water's edge and the point of engagement or the depth of the pathway below a channel low point. In general, permitting delays can be minimized by understanding the cabling route and initiating permit requests as early as possible.

Underground deployments are safer and faster. After lengthy route planning, design and permitting phases, OPGW has historically been installed using helicopters when the transmission line is put in place. Underground fiber installation typically is less time-consuming. With the transmission ROW already designed and fewer permits required, construction can begin on some segments even as surveys and final design are completed on others.

The process is aided by geographic information systems (GIS), highly detailed software that has greatly simplified the mapping process. GIS makes it possible to import field survey information — including transmission tower locations, ROW route information, and habitats of threatened or endangered species — and consolidate it with publicly accessible data on a map interface. The resulting near-real-time maps, which can be updated as field conditions change, are available to design team members for speedy decision-making.

Underground installation also calls for less specialized training than OPGW; underground fiber cabling crews are not required to have the same training as linemen working overhead. Depending on the terrain, environmental issues and logistics, cable can be installed using either open-trench excavation or horizontal directional drilling (HDD). While open-trench methods can cost substantially less than HDD, they are not suitable for all terrains, such as wetlands, mountainous regions or roadways. Advanced HDD technologies can create pathways with minimal disturbance to ecosystems and habitats, making them a better choice when environmental preservation is critical.

Maintenance and repair costs are minimized. The same factors that make OPGW challenging to install also make it difficult to maintain and replace. Constant exposure to the elements shortens its life span and puts it at risk for storm and wind damage that would require power line–trained aerial crews and heavy equipment to repair. Wildlife can cause challenges through corrosion, chewing and other general disruptions to the overhead fiber plant. When OPGW is damaged, outages and temporary rerouting of power service are common requirements for remediation. Many of these risks and costs are minimized or eliminated when the segment is buried in the ROW. Upkeep on underground fiber is minimal and can typically be performed by local communications contractors.

Strand counts are expandable to meet future demand and tap new revenue streams. With cables typically housing 48 to 96 strands of fiber, existing OPGW systems are sized to meet current needs. Their ability to address future demand is less certain. Cable configurations in which the new cable is significantly larger than the existing wire can cause significant loading issues for the structures, primarily from radial icing load. The increased radial icing load causes the weight of the cable to go up exponentially. The weight of additional overhead cables and connectors can threaten the structural stability of transmission towers, making it more complicated to put additional fiber loads on those towers.

By imposing virtually no strand count limits, underground installations eliminate these risks while opening doors to new revenue streams. Utilities have historically increased income by leasing dark fibers and ducts to ISPs. More recently, federal investment in broadband has expanded markets that can be easily reached by the utility companies, either by delivering broadband directly to end users or by providing pathways for carriers to access these customers.

As utilities continue to expand into carrier markets, the flexibility and capacity of underground fiber directly impacts the decision-making process for fiber placement and construction. Many bury additional ducts at the time of the initial fiber installation. These supplementary pathways give utilities the flexibility to add fiber later without incurring service outages.

An Attractive Business Proposition

Utilities' ability to place fiber cabling underground along transmission ROWs puts them in an enviable position for data transport markets. The installation of underground fiber will do more than just support SCADA and other utility network and communication services. It will also enable utilities to expand into carrier markets and bring broadband to unserved and underserved areas, creating opportunities for cost improvements and multiple lanes of new and expanded revenue streams. It will also provide redundancy for the fiber optics already installed overhead.

Given its long-term advantages, underground fiber-optic construction is expected to play a key role in the power sector's growth and profitability for the foreseeable future. Utilities seeking to expand their fiber connectivity would be wise to look beyond their existing OPGW installations and consider this advantageous approach. By working with well-credentialed design and construction partners, they can complete these installations quickly, cost-effectively, and with fewer safety and maintenance concerns than their overhead counterparts.

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