WHITE PAPER / **STRATEGIC UNDERGROUNDING**

IMPORTANCE AND BENEFITS OF GOING BENEATH THE SURFACE

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A customer service-focused strategic undergrounding program for electrical distribution systems provides an enhanced customer experience through improved system reliability, increased resiliency, and positive touch points throughout the design and construction process.

Natural disasters and accidents are the leading cause of electrical system outages and Customer Minutes of Interruption (CMI). These events represent a significant challenge for utilities. Damage from hurricanes, tornadoes, heatwaves, wildfires, wind and ice storms, and traffic accidents are difficult to track, and they negatively impact distribution system performance, which leads to decreased customer satisfaction.

Strategic undergrounding is a data-driven approach used to identify key overhead distribution feeders, equipment and communication lines that are candidates for proactive undergrounding. A strategic undergrounding program assists in identifying the lines that are most prone to outages and that should be considered for undergrounding to improve grid reliability and system resiliency.

Enhanced reliability, improved system resiliency and a positive customer experience are key to development of a strategic undergrounding program. This paper outlines the processes and critical steps needed in each stage of a successful undergrounding program to deliver a positive program outcome for all stakeholders.

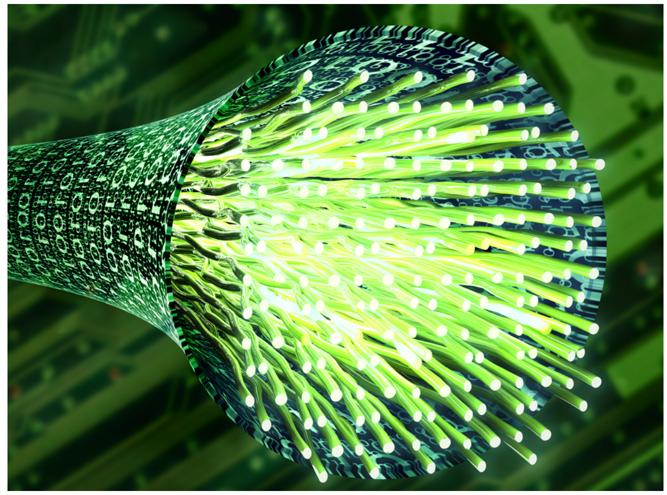
IDENTIFYING LINES BASED ON DATA ANALYSIS

Overhead lines that are most prone to outages are identified through a data analysis process. This involves analyzing an accumulation of outage data — years' worth, to the extent possible. Based on the results of this analysis, areas most affected by outages that could benefit from undergrounding are identified.

This data-driven process helps utilities adopt a transparent, systematic approach and allows distribution planners and project managers to prioritize projects for undergrounding based upon objective metrics.

DESIGN PHASE

Prior to design, planners and project managers submit tickets to the state's 811 one-call utility location service to begin identifying existing underground utilities in the area. Marks signifying existing utilities are placed on the roads, sidewalks and easements around the relevant houses. Planners or inspectors perform field inspections, and surveyors conduct topographic surveys and subsurface



utility investigations (most likely radar-based). All these activities gather data for planners and designers to create a constructable underground design that avoids existing underground utilities and is well coordinated with overhead interconnection points, such as meters at customer homes and cable poles where circuits transition from overhead to underground. This phase also provides an opportunity for the undergrounding program team to host public meetings and town halls to give property owners an opportunity to provide suggestions or highlight any concerns they might have with the process.

After obtaining preliminary field agreement with customers, city inspectors and other stakeholders, and after field analysis is complete, a detailed design is initiated. This phase includes creation of a preliminary project schedule, gathering equipment location information, determining necessary access to owners' property during construction, and planning for any short-term outages required for equipment transfer. All this work is prepared in accordance with approved utility processes and procedures to facilitate smooth project execution.

PROPERTY EASEMENTS

Property easement acquisition is performed concurrent with the design phase. The necessary permissions are obtained from property owners within a project area to perform the undergrounding work. It is extremely important to have a comprehensive and efficient easement process to obtain landowner approval in a timely manner. This avoids project delays, which could lead to increased project expense and customer dissatisfaction.

After the design is complete, property owners and other stakeholders are once again invited to discuss the design, equipment placement, project timelines and construction phase working hours. This gives the community an opportunity to provide additional feedback or suggestions. Tools such as augmented reality can be used to show property owners the equipment locations relative to their property, as well as demonstrating the drilling, trenching, conduit and cable installation, and restoration techniques. At this point, the design team seeks appropriate approval from all parties, including property owners, city inspectors and any other key stakeholders, so that preparations for procurement and construction can begin.

SCHEDULING AND PREPARING

A comprehensive construction plan is prepared and communicated to property owners and key stakeholders. Keeping customers informed of construction dates, property access times and locations, system outages, and restoration activities helps enhance the customer experience and minimizes potential construction delays, which can be costly and negatively impact public perception of the undergrounding program.

During this phase, general contractors and equipment vendors are identified, and the detailed undergrounding design and approach is shared with them. Feedback and suggestions from key stakeholders are also considered, and workers, tools and methods are finalized. Construction managers work closely with vendors and contractors to guide them and make sure all work is in accordance with the approved plan while trying to see that commitments to customers and inspectors are met.

BUILDING AND CONVERTING

Communications with property owners about requests for access to property should occur before the start of construction. It is extremely important to obtain final approval for the project to be successful.

Undergrounding of cables and removal of overhead cables consists of four parts: trenching or boring, cabling, cutovers, and pole and equipment removal:

1. Horizontal directional drilling (HDD) is often preferred over open trenching as a method to install conduit and cables. This is for several reasons: HDD is faster; can be more cost-effective as fewer operators are required; involves fewer permit issues; and promises minimized impacts and faster restoration of the landscaping. This requires careful planning and a comprehensive site plan for the construction zone, which is shared with the drilling professionals to help them identify the drilling locations and carry out their tasks.
2. After the conduits and support equipment (such as manholes and switch cabinets to support splicing and termination points for cable) are installed, new transformers, platforms and cable boxes are also installed beneath the surface. Having this equipment and supply cables underground eliminates exposure to wind, rain, ice, traffic and other hazards, and it improves system reliability and resiliency.
3. After the construction and installation of the new underground system, there will be a brief planned outage to connect customers that are being cut over from overhead to underground feeds. Property owners will be informed in advance, and all service connections to homes and businesses are prepared to receive service through the underground network via conduit and service runs to customer meters. Finally, they are switched over from the overhead lines to the new underground network.

4. Poles and other equipment on the overhead lines are removed by cranes and aerial man-lifts after all customers are cut over to the new underground system. These poles and equipment are then transported to an approved site for disposal.

PROPERTY RESTORATION

The last phase of the undergrounding program is restoring the property to owner expectations. Project representatives or authorized contractors will work closely with customers to satisfy property owners with the restoration work, taking customer feedback as well as allotted restoration budget into account. Restoration work can include fence installation and repair, backfilling any trenches, landscaping, and placing sod or gravel as necessary. The project is considered complete only after all the properties connected to the newly undergrounded system in an area are restored.

Damage to surrounding facilities and property is minimized and restoration efforts are completed in a professional and timely manner.

CONCLUSION

A customer-focused and design-minded approach helps mitigate risks and identify the optimal options for executing any project. Undergrounding of cables can be an effective solution to curb unnecessary customer outages while protecting utility infrastructure. Adopting a strategic methodology further streamlines this process, keeping all stakeholders appraised.

Undergrounding significantly improves the appearance of an area by removing the clutter of overhead utility wires and providing more space for public beautification, such as landscaping and planting trees. This helps to enhance customer experience through higher property values and enhanced property utilization.

In addition to outage reductions and enhanced customer experience, undergrounding greatly improves road safety by reducing the number of poles and electrical equipment above the ground that motorists could potentially hit.

While the cost of undergrounding cables is higher than overhead power cables, this cost can be significantly offset by increased reliability and resiliency through reduced system outages and lower O&M expenses over the life of the equipment.

Strategic undergrounding, when planned and executed properly, brings a comprehensive level of stacked value and benefits to communities everywhere.

BIOGRAPHIES

ANTHONY GASKILL, PE, is an electrical engineer at Burns & McDonnell. He has over five years of experience in transmission and distribution, underground cable replacement and overhead storm hardening project management, substation design, and the design of electrical distribution systems within industrial facilities. Anthony has a Bachelor of Science in electrical engineering from Oklahoma State University.

GARY HUFFMAN, PE, is the distribution modernization business development manager for Burns & McDonnell. He has 30 years of experience in managing all aspects of transmission, distribution and substation projects, from regulatory policy and field operations to engineer-procure-construct (EPC) program management and storm recovery. Gary currently serves as vice chair of the EEI Distribution Reliability Committee and the IEEE Distribution Resiliency Working Group. Gary has a Bachelor of Science in manufacturing engineering from Cal Poly Pomona and a project management certification from the University of California, Irvine.

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