BURNS & McDONNELL

WHITE PAPER / **UNDERGROUND DISTRIBUTION**

UPGRADING AND EXPANDING UNDERGROUND INFRASTRUCTURE

BY **Colleen Madden** AND **Anna Sleeter**, PE

Locating power lines underground has many benefits. Because underground distribution makes for more attractive streetscapes, the public prefers it, too. Utilities face multiple challenges as they upgrade, update and extend their underground distribution networks. A plan that works within existing organizational and infrastructure frameworks is a good place to start.

Underground distribution can be an excellent solution for electric utilities seeking to meet customers' power reliability demands and expectations. More resilient in extreme weather and offering a longer service life than the above-ground alternative, underground lines are currently the power distribution method of choice among large utilities that serve congested urban areas. Because they are more expensive to construct and expand, it is less common for them to be used for the transmission lines that carry electricity over long distances or for distribution facilities in less-congested suburban or rural environments.

In the coming years, much of the nation's underground distribution infrastructure will need to be updated, upgraded or expanded to adhere to new industry standards and meet changing needs associated with urban redevelopment. Many of these projects will be focused on existing lines that are aging or overloaded and must be upgraded to meet future demands. Some projects will be needed to address maintenance needs or manufacturing defects in existing assets. Other projects will be initiated because both overhead and underground lines need to be relocated to make way for new development.

Many projects will be designed to improve system safety and enhance the reliability of the power supply to critical customers, including hospitals, fire and police stations, sewer treatment plants, and other customers whose services are essential to a community's health, welfare and safety. In many cases, these projects will be completed in conjunction with — or very well might conflict with — road construction, sewer rehabilitation or other public improvement projects. How competing needs will be negotiated will depend on the specific requirements of the authorities having jurisdiction, which frequently require extensive coordination with other involved entities.

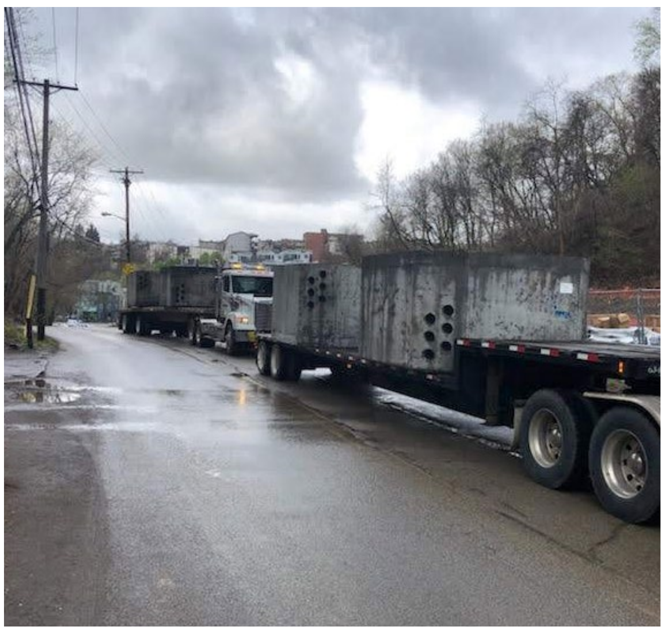
Electric utilities that want to add more duct packages and manholes to existing underground systems to accommodate increased capacity may need to work with water, sewer, gas, telecommunication and other electric utilities to negotiate underground space. When high-voltage cables are involved, parties are reasonably protective of their space, cautious about maintaining a safe underground environment, and minimizing impacts to their facilities due to the high cost and long time frames needed to relocate transmission cables.

THE CHOREOGRAPHY OF CHANGE

While the need for these major replacement and upgrade projects is great, widespread implementation has been slow, often due to the lack of resources needed to map assets and plan and execute the work. But utilities must begin somewhere, and there is no better place than with the development of an underground distribution replacement road map that works within the bounds of their existing organizational and infrastructure framework. Such a road map typically includes the following steps.

STEP ONE: DEFINE REPLACEMENT CRITERIA

Given the finite resources a utility has at its disposal, it's important to identify goals and objectives, as well as to establish criteria that will guide the identification and selection of underground line replacement projects. For example, criteria might limit projects to a particular kind of equipment, cable of a certain age, or needs within a specific geographic area.



STEP TWO: ESTABLISH PRIORITIES

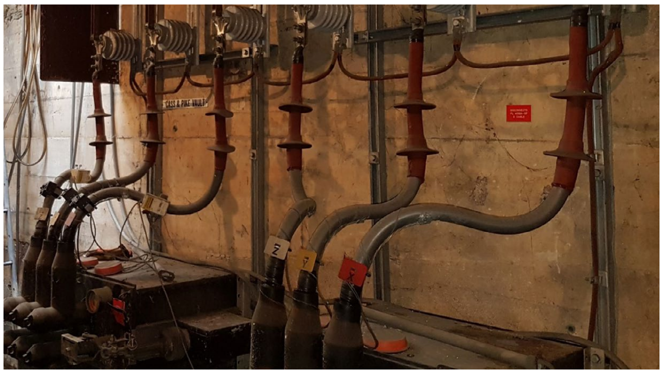
Using the established criteria, create a list of potential projects. Next, this list needs to be prioritized. This can be achieved by measuring each project's construction and operating costs against the long-term value it will deliver to customers. Value might be measured by a range of metrics, such as outage reductions, outage duration, number of customers impacted, and other factors indicative of a reliable and resilient power network.

When establishing priorities, it's also helpful to take a closer look at the physical environment for these projects. This investigation should be designed to identify any constraints that may limit the project scope, such as railroads, highways, bridges, waterways, wetlands or land acquisition requirements, or that require coordination with other utilities.

STEP THREE: COLLECT AND REVIEW EXISTING UNDERGROUND DISTRIBUTION SYSTEM DATA

While most utilities have some type of asset management system, many such systems are not yet fully digitized and comprehensive for both overhead and underground assets. The information in these systems is often incomplete, incorrect or altogether missing. It may also be accurate from an electrical connectivity perspective, but not from a physical location perspective

There are many reasons for this. As-built construction documents are sometimes unavailable because paper records were poorly maintained, lost or never converted to a digital database. Institutional knowledge that can be helpful in piecing this information together may also be lost as an aging workforce retires.



To see that decisions are based on current, accurate information, utilities are advised to conduct a physical inventory of system assets, recording the type and condition of equipment and the location of existing circuits. 3D scanning, data collection and storage systems have streamlined the data collection and transfer processes. The goal: to create a complete, inclusive picture of the distribution system, including any gaps in information that need to be filled.

STEP FOUR: REASSESS PRIORITIES

Information is a powerful thing. The inventory-taking process may uncover records that are incomplete or based on assumptions rather than documented evidence. It may also identify new areas that require focus or demand that the system be viewed in a new or different light. In some cases, utilities may be required to rethink initial assumptions and reprioritize needs before time and effort is expended on a formal scope of work.

STEP FIVE: DEVELOP A SCOPE OF WORK

Developing a scope of work involves project execution planning, including resources, budget and a schedule that identifies project milestones and goals. For example, the scope of work might specify the amount of underground cable to be replaced or the number of circuits to be upgraded.

The scope of work should also proactively identify ways to future-proof these systems. In addition to identifying current upgrade needs, it should contemplate how new development or redevelopment may impact future needs. An assessment of stakeholder management is also helpful. The needs of permitting agencies, property owners that will require buyouts, adjacent utilities and local municipalities should be identified and included in timelines.

STEP SIX: ALLOCATE DEDICATED INTERNAL RESOURCES

Determine what internal resources are available and able to work on underground distribution projects. The utility should also consider what it is willing to assign to outside consultants and contractors. Well-staffed utilities may prefer to have internal staff manage risk, rather than assign such risk to outside resources. Others opt for the opposite approach. Each utility must define its internal capabilities and risk tolerance while balancing partnerships with outside service providers, which can provide experience that is nonexistent internally.

STEP SEVEN: SELECT A PROJECT DELIVERY METHOD

The scope of work, timeline, available in-house resources and funding sources will dictate how utilities approach the actual design and construction process. For smaller, internally managed efforts, they may choose to focus on one project at a time and outsource certain design and construction functions to consultants and contractors. For more aggressive timetables, they may seek new or additional funding sources.

A more programmatic approach may be in order for larger efforts, including those with projects that affect adjacent infrastructure, require extensive utility coordination or the rerouting of numerous circuits, or must be executed around line outages. In these cases, a utility might engage a program manager who oversees and coordinates multiple individual projects.

Utilities that choose to outsource significant portions of these complex assignments may gravitate toward the engineer-procure-construct (EPC) method of project delivery, an approach that obligates the EPC contractor to execute and deliver a project within an agreed-upon time and budget. EPC enables utilities to transfer significant responsibility for risk management to their contractors. Because many EPC processes occur in parallel, this method also can often result in more condensed schedules than a traditional design-bid-build approach. Utilities that perform these functions in-house with limited outside support, in contrast, take ownership of these risks, and will find those functions competing with other projects internally to secure resources, which could result in schedule constraints.

GETTING STARTED

Utilities contemplating a major underground distribution upgrade program for the first time may be reluctant to begin, given that it may require making changes to traditional approaches and systems. That should be expected.

By breaking down the planning process into steps and developing a road map for completing these project goals, utilities can determine how to optimize the use of their available funds and resources. They can also ascertain how to supplement their efforts with consultant and contractor contributions to address priorities. This approach should result in the greatest improvements to reliability and customer satisfaction, both in the near term and for future generations.

BIOGRAPHIES

COLLEEN MADDEN specializes in underground electrical distribution and subtransmission projects ranging from 600-volt to 129-kV for conduit and cable design. Her responsibilities in the Transmission & Distribution Group at Burns & McDonnell include department and project management, client interface, engineering design and construction support. She has additional experience in a variety of electrical distribution and telecommunications underground utility projects.

ANNA SLEETER, PE, is a senior civil engineer in the Transmission & Distribution Group at Burns & McDonnell. Her experience includes the design of underground distribution and underground transmission conduit installations, distribution and transmission routing feasibility studies, project management, and resident engineering. She has experience on conduit projects involving multiple installation methods, including open cut trench, directional bore, box tunnel, and jack and bore.

ABOUT BURNS & McDONNELL

Burns & McDonnell is a family of companies bringing together an unmatched team of engineers, construction professionals, architects, planners, technologists and scientists to design and build our critical infrastructure. With an integrated construction and design mindset, we offer full-service capabilities with offices, globally. Founded in 1898, Burns & McDonnell is a 100% employee-owned company and proud to be on *Fortune*'s list of 100 Best Companies to Work For. For more information, visit **burnsmcd.com**.

15560-UGD-0221