BOLD®: A Perspective from Siting, Project Outreach and Environmental

Laurie Spears
AEP Transmission Sr. Siting Specialist
Tama Davis
AEP Transmission Project Outreach Manager

BOLD® (Breakthrough Overhead Line Design) is a high-capacity, high-efficiency transmission line design created by American Electric Power (AEP) engineers that optimizes structure geometry through the use of curved steel arms and compact conductor phase spacing. The unique geometry and electrical characteristics of a BOLD transmission line can be designed and constructed in a manner similar to typical transmission line projects; however, there are several considerations involving siting and public outreach with regard to BOLD projects.

AEP designed and built the first BOLD line to enter service near Fort Wayne, Indiana, to replace an existing aging and underpowered line. The unique electrical characteristics of BOLD helped AEP address the capacity and reliability needs of the area while providing line siting specialists and project outreach with a solution to the common challenges of line routing and gaining public acceptance presented by transmission line projects.

Introduction:

American Electric Power (AEP) recognizes the challenges facing the electric utility industry today in developing solutions to transport more energy, revitalize the grid by rebuilding outdated infrastructure, utilize existing rights-of-way and incorporate public input into the process.

AEP has an impressive history of designing technological solutions for transmission. One of the latest developments in AEP's engineering legacy is BOLD®, the Breakthrough Overhead Line Design. With its compact line design, BOLD is capable of moving more power while reducing structure heights and increased efficiencies in existing rights-of-way. Given the recent completion of a BOLD installation in Indiana and more projects in the planning and implementation phases, additional benefits for siting and public outreach are now evident. This paper provides targeted information for siting and public involvement subject matter experts on the benefits of BOLD technology for greenfield and rebuilds projects.

Transmission Line Siting and Stakeholder Approval

Today most utilities use some form of siting methodology when selecting routes for new transmission lines, which is driven by a formal regulatory requirement by a state public utilities commission or in support of right-of-way acquisition. Regardless of the specific methodology used, there are elements consistently evaluated, such as environmental impacts, existing land use, public involvement, constraints and infrastructure opportunities.

In order for a new line or a rebuild project to be approved, often the utility must show it has conducted an analysis of alternatives, gathered public input and made an effort to minimize impacts to the natural and human environment. While some impacts are unavoidable, a solution such as BOLD can minimize and reduce impacts. When comparing traditional structures to BOLD, the new design can require a narrower right-of-way for increased capacity, offer a reduced structure height and an appealing design; all of which addresses aesthetic concerns of property owners and the general public.

Greater detail is presented the following case

A Case Study – Boldly Maximizing the Use of Existing Rights-of-Way

Powering Up West: Roanoke to Robison Park

Project Details: Expansion of the existing Sorenson substation and a 22-mile, 138-kV transmission line rebuild with a 345/138-kV hybrid line design between Sorenson and Robison Park stations. BOLD tubular steel pole structures average height is 120-feet in 150-foot right-of-way.

This project solution emerged from the planning process as the best option to solve the system needs. Other options considered included a long green-field 345kV line, increasing the capacity to the existing 138kV system through rebuilds and reconductoring. Both solutions were reject for cost and schedule impacts.

Project Status: A 6.5-mile segment of the rebuild was energized in the summer of 2015; the entire line entered service in November 2016.

study for a project in northeast Indiana that is part of the Greater Fort Wayne Reliability Improvements. The project is in AEP's Indiana Michigan Power service territory.

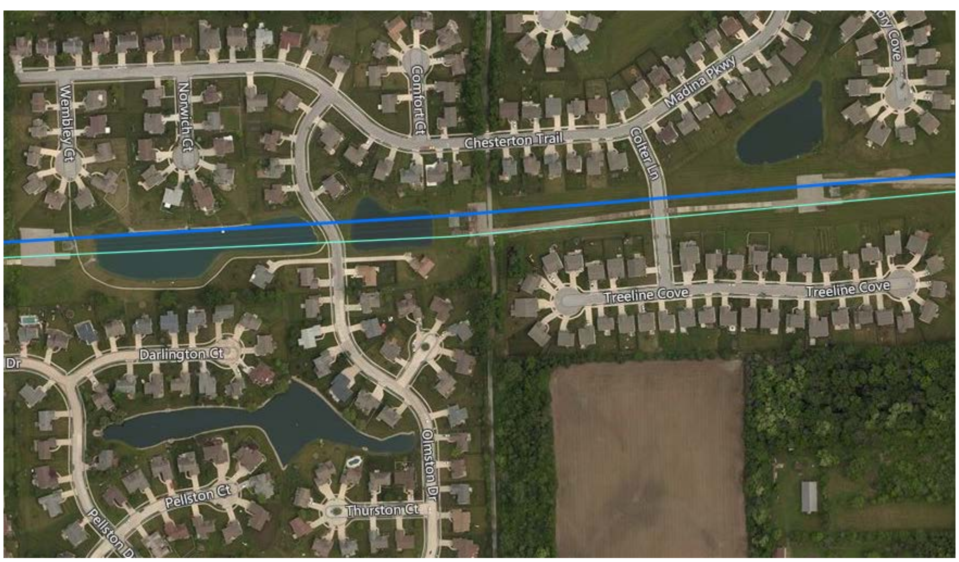
The U.S. electric transmission grid consists of over 200,000 miles of high-voltage transmission lines [source: EEI]. Widescale construction of new and replacement lines is currently driven by reliability needs, evolving generation sources and an aging infrastructure. At the same time, finding new and supplemental rights-of-way to construct transmission lines is an ever increasing challenge, especially in established communities and urban areas.

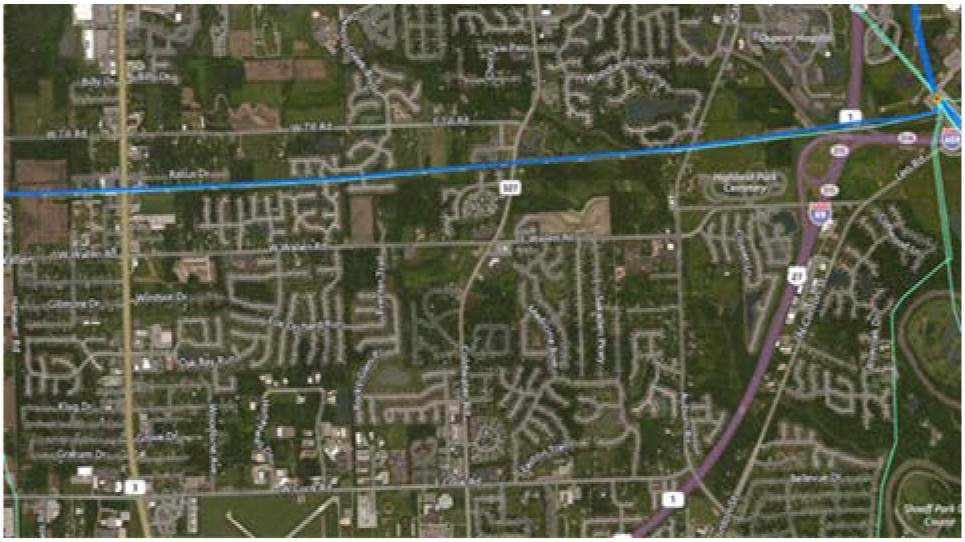
Public acceptance of power lines and substations is generally low, while opposition to new infrastructure projects is often substantial. Simply rebuilding or upgrading existing transmission lines can be sensitive as property surrounding rights-of-way may have been developed in the years since its original construction.

One benefit of the BOLD technology is that it enables new transmission infrastructure to be consolidated into existing rights-of-way, often at higher voltages. This can maximize land use by providing increased capacity within an existing right-of-way, while minimizing additional impacts for landowners. The Sorenson to Robinson Park 138/345 kV Transmission Line Project (Sorenson BOLD) illustrates the rights-of-way benefits, while also reducing project costs.

The exising 22-mile transmission line near Fort Wayne, Indiana, was originally constructed in 1927. The double-circuit 138-kV line mounted on steel lattice structures had forcasted voltage and thermal problems and was slated for a rebulid as a conventional 345/138 kV transmission line between Sorenson and Robinson Park substations.

The existing right-of-way for the tranmission line was 130-feet wide. Since the line was orignially constructed, significant development has occurred adjacent to the existing corridor, including homes and subdivisions bordering the edge of the existing right-of-way (Figure A and B). In addition, the existing transmission line paralleled two additional 138-kV lines for approximately three miles (Photo 1).





Figures A and B – Google Earth images illustrate the dense development around the existing transmission line in suburan Fort Wayne, Indiana.

Photo 1: The middle 138-kV line was earmarked to be rebuilt as a double-circuit 138/345-kV line using the BOLD design.

The state of Indiana does not have a regulatory approval process for the siting of transmission facilities. However, to determine the most reasonable option for rebuilding the project, the team evaluated re-routing the transmission line around developed areas and utilizing the BOLD technology on the existing centerline with a structure-for-structure replacement. Several alternative routes were developed and analyzed for feasibility (Figure C).

Figure C: Alternatives considered for the rebulid of the transmission line.

In the southern portion of the study area, rebuilding on the existing centerline (Route A) would require approximately 19-acres of new right-of-way to accommodate the extra width (10 feet on either side of centerline).

The two alternative routes (Route B and Route C) shown in Figure C would require an additional 133-acres to 220-acres of new right-of-way.The cost savings for using the existing rights-of-way was substational, along with reducing construction costs for a longer re-route.

Figure D: Alternative Routes in the Southern Portion of the Project Area

In the northern portion of the study area, staying on existing centerline (Route D) only required 5.5 acres of new right-of-way compared to 19.6 or 46.6 acres with the two alternative routes (Figure E). Similar to the southern portion of the study area, the cost savings for staying on the existing centerline were significant for construction and right-of-way costs combined.

Figure E: Alternative Routes for the Northern Portion of the Study Area

From a siting and public involvement perspective, the impacts to landowners were significantly decreased by using the existing right-of-way and replacing the outdated structures with BOLD monopoles on a structure-for-structure basis. The smaller-based, BOLD monopole also benefited farmers with smaller footprints to farm around when planting and harvesting near the structures.

The following photos highlight the decreased land impacts. The new BOLD towers have a seven-foot diameter base, while the existing lattice towers had a 22-foot wide footprint. Photo 2 shows the base of the replaced lattice tower in front of the new BOLD tower. Photo 3 shows the now energized BOLD line operating in the maintained easement.

Photo 2:

The footprint of the new BOLD structure compared to the existing lattice tower.

Photo 3:

The newly constructed BOLD structures located near residential areas.

Environmental Benefits

In addition to right-of-way considerations, impacts to environmentally sensitive areas or species are also significant factors for greenfield and rebuild transmission line projects. Using existing rights-of-way typically provides environmental benefits, such as minimizing land clearing associated with a new route. From an environmental perspective, BOLD's ability to increase capacity over conventional designs could lessen the need for additional lines, and thus reduce land use and environmental impacts.

For the Sorenson BOLD project, forest clearing was a major environmental consideration for the alternative route comparison. The project area falls in the known territory for the Indiana Bat (*Myotis sodalist*), an endangered species. Tree clearing in this area must be completed in a specified window (November to March) or extensive surveys must be completed prior to the start of construction.

In the southern portion of the project area, using the existing right-of-way limited additional clearing to approximately nine-acres compared to the alternative routes that would require 20 to 29-acres of additional clearing. In addition, the nine-acres would slightly expand the maintained right-of-way compared to a new corridor for either of the alternative routes.

In more heavily forested areas of the country, this mitigating factor could be a significant benefit. Environmental permitting can be costly and time consuming. Regulatory agencies typically expect utilities to use existing rights-of-way, when possible, to lessen fragmentation of forests and avoid new impacts. BOLD offers the ability to use narrower, existing rights-of-way for higher voltage transmission projects. From an environmental perspective, consolidating the impacts into an existing corridor is preferable over the creation of a new right-of-way, in most cases.

In some cases, existing rights-of-way may not be suitable for new construction and a new route must be permitted. BOLD technology also delivers benefits to greenfield projects because of the decreased right-of-way needed to meet electrical standards and BOLD's reduced audible noise and electromagnetic fields, which allows for a narrower right-of-way.

In Figure F, the right-of-way widths are shown for a 345-kV double circuit optimized for long spans (left), a 345-kV double circuit optimized for narrower rights-of-way (middle), and a 345-kV single circuit optimized for a narrower right-of-way (right). During the siting process, situations arise where a reduced right-of-way with more structures may be preferable over a wider right-of-way with long spans.

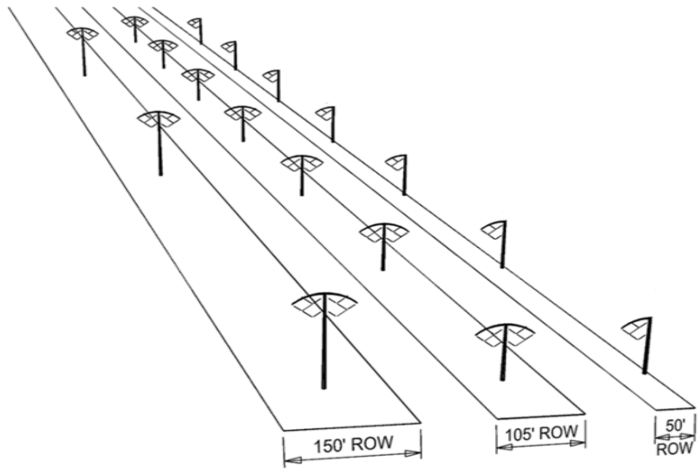


Figure F: Various right-of-way widths optimized for span length or right-of-way.

Figure G illustrates BOLD's increased capacity. The breakthrough technology delivers 40 to 60 percent more capacity in the same right-of-way as traditional designs.

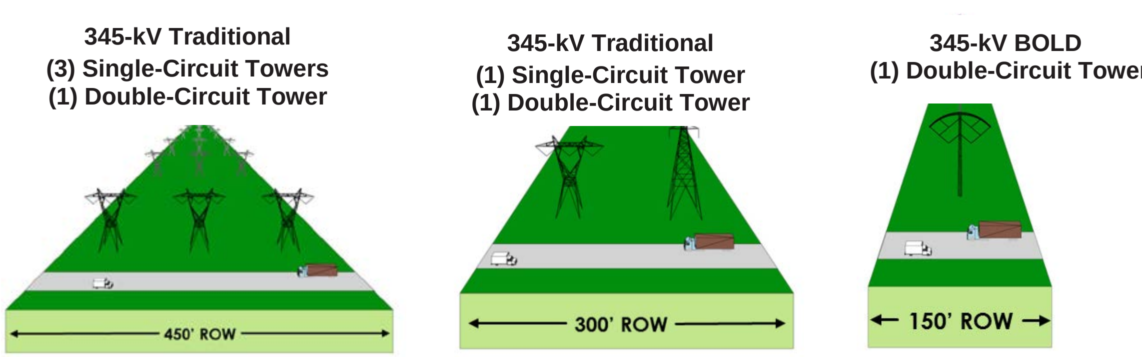


Figure G: Comparison of the amount of power that can be transmitted with BOLD in a smaller right-of-way as compared to other structure types.

BOLD Being Studied for Avian Protection

The Avian Power Line Interaction Committee (APLIC) was formed in the 1980s to address avian interactions with power lines (both distribution and transmission). A number of studies revealed the shield wire is most often the culprit in these incidents (APLIC 2012). As birds fly higher to avoid contact with the conductors, they collide with the shield wire, which is smaller in diameter and more difficult to see (particularly in poor lighting conditions).

Figure H offers a comparison of a typical steel structure with BOLD. The shield wire is located on top of the arching arm, closer to the bundled conductors. On a typical structure, the shield wire is located above the conductors, creating an additional wire for birds to clear. As the comparison illustrates the higher shield wire equates to an additional 46 feet birds need to safely ascend and clear the typical transmission line.

← Shield wire

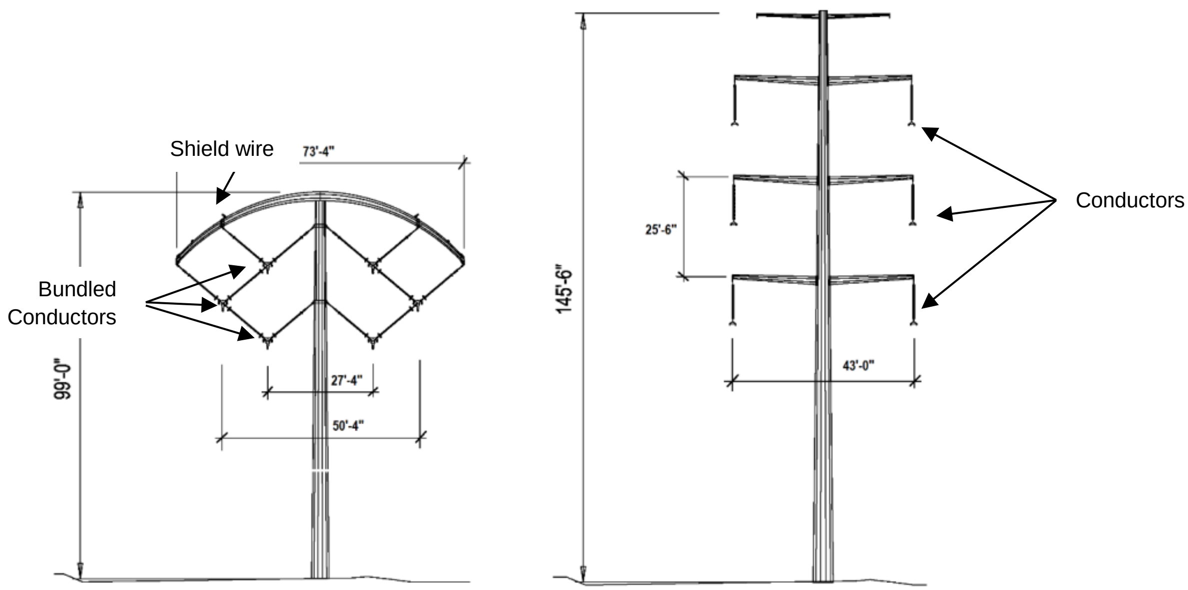


Figure 7: Traditional signal pole vs. BOLD single pole

In Photo 5, the height of the tree line is comparable to the height of the structure. For avian species flying over the forested area, the lower height of BOLD also allows the birds to safely pass over the transmission line without having to increase altitude as they would for taller transmission line structures. The compact design and bundled conductor of the BOLD 345-kV line allows for shorter structures that blend into tree lines, instead of protruding above them.

Photo 5: The height of the BOLD structure as compared to the tree line.

While the impacts to avian species with the new BOLD technology are still being studied, the compact design may prove to help minimize collision risk for avian species.

Photo 6: AEP Siting and Engineering team members recently asked avian expert Rick Harness (EDM International) to survey the BOLD line to determine the benefits of the structure design.

The Value of Project Outreach and Stakeholder Involvement

Providing transparent information is key to gaining acceptance for transmission line projects such as the case study "Powering Up West: Roanoke to Robison Park." AEP Transmission's project outreach approach is designed to educate, engage and inform landowners, communities and other stakeholders throughout the process with clear, concise communication.

In this era of social media, Change.org petitions and grass-roots opposition groups, a recent media analysis highlighted six common issues the public typically raises about transmission line projects. The Center for Rural Affairs—a nonprofit think tank in Lyons, Nebraska—reviewed 100 recent media reports that included public reaction to projects in the Midwest, including Indiana. The six top concerns include: agriculture, conservation, health, eminent domain, project need and fairness.

After identifying these issues and causes, the analysis concludes increased communication between communities, landowners and utilities can ease opposition.

BOLD 345/138 kV and fits into the landscape of an Indiana farm, blending into the tree line.

When BOLD was first presented as the option for the case study project in 2013, it was met with interest and curiosity. The new technology was intriguing to the local residents and the majority found the design visually appealing. The monopole base was also widely accepted, especially by directly impacted landowners.

Outreach efforts included an open house, project website, email submissions, along with conversations with stakeholders and property owners. There were inquiries reflective of the six main concern areas as identified by the Center for Rural Affairs; agriculture, conservation, health, eminent domain, project need and fairness. In this case, the project need was understood given the age of the existing infrastructure. BOLD was seen as a futuristic solution to address any concerns around agriculture (land use), conservation (minimal supplemental easements needed and the ability to transport more energy in the same amount of right-of-way). Fairness and eminent domain did not become issues given the level of communication and successful supplemental easement negotiations. Right-of-way agents found property owners to be very accepting of the new technology and the investment in the area's transmission grid.

Linking Grid Benefits to Land Use

Educating the public about the need for the BOLD project included discussion around strengthening the region's transmission grid. There has been much discussion about building a "smarter grid" and the advantages of new technology to make the system more efficient to benefit electric customers and the environment, as well as to deliver renewable energy to more communities.

The BOLD project is a textbook example of the enhancements driven by the design. Engineers were able to build a much higher voltage 345-kV line in the right-of-way of an existing lower voltage line. With just 19-acres of supplemental easements on a 22-mile line, the BOLD double-circuit configuration increases movement of electricity by over 2,000 MW – making the line five times as efficient without significantly impacting landowners or the natural environment. In discussions with the public, community leaders and property owners, this example supported our efforts to respect the environment and people, while finding ways to deliver the reliable electricity with the least amount of impacts.

BOLD can address concerns about land use and the desire to effectively deliver large blocks of power over long distances, connecting remote renewable generation projects to the power grid and load centers while boosting the load capacity of extra high-voltage lines by up to 60 percent in the same right-of-way. It can also increase capacity in the same right-of-way when replacing existing old lines with state-of-the-art technology. This level of stewardship is a key factor in gaining support from stakeholders and regulators, as well as communities and directly impacted property owners.

Focus on BOLD - Beyond the Case Study

To benchmark public opinion and support for BOLD, AEP conducted national focus groups. The in-depth survey included participants who live in a variety of geographic locations:

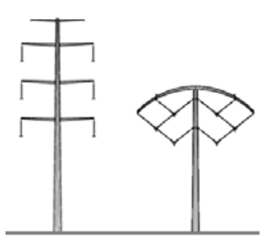
- ✓ 50% of respondents described the terrain where they live to be flat/plains
  - 29% hilly
  - 12% coastal
- ✓ 57% of respondents described the area where they live as Suburban
  - 27% urban
  - 16% rural

The survey asked participants their opinion about investing more for infrastructure with added benefits.

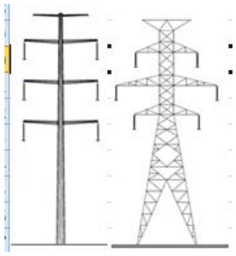
- ✓ 91% of respondents would accept their local utility spending more money for “more environmentally friendly and efficient transmission line compared to what is used today”
- ✓ 76% of respondents would be okay with their local utility company spending “a little more money for a transmission line that is more visually appealing compared to a standard transmission line”

The survey also gauged the more visually appealing design of BOLD.

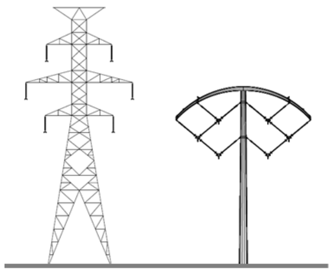
- ✓ 70% of respondents preferred the BOLD tubular design vs. a conventional monopole



- ✓ 74% of respondents preferred a conventional monopole design vs. a conventional lattice design



✓ 77% of respondents preferred the BOLD tubular design vs. a conventional lattice design



When survey participants were shown the illustration below, a majority said they would support a higher cost for advanced technology.

- 64% of respondents would prefer a "greater cost but use of advanced technology" if a new transmission line was being built near their home vs.
- 14% - "today's current technology"
- 22% - "least expensive possible design"

Visual Aesthetics

Additional responses confirmed participants preferred more than simply the aesthetics of BOLD, they also valued the height reduction provided by the innovative design because shorter structures lessen visual impacts and blend into the landscape.

Structure heights for typical 345-kV transmission lines average 150 feet. In most cases, the same voltage BOLD structure would be around 110 feet.

Added benefits are also visible when the BOLD structure is viewed from its profile. The curved arm provides a sleeker side view, covering the conductor and narrowing the impact to the surrounding environment.

BOLD 345/138-kV sleek profile

BOLD conductor configuration with sleek, curved arm minimizes the profile and creates an elegant silhouette

The newly energized BOLD line fits into the skyline of Indiana farm country during the summer growing season.

Conclusion

BOLD offers a flexible solution that can maximize limited righ ... nd environmental concerns, provide technology to deliver rene ... gn that can garner public support.

As the breakthrough technology gains attention, BOLD is being seen by the utility industry as a new standard. In a recent article in *T&D World Magazine*, the author acknowledges the importance of what BOLD means to tomorrow's energy grid.

"The transmission grid has experienced ongoing and dramatic changes as a result of open access, regional markets and changes in the nature and location of generation sources. Widespread outages caused by natural events and the threat of physical attacks have driven the need for greater resiliency. At the same time, the public resists construction of new lines because of aesthetics and other reasons, especially higher-voltage lines that more efficiently deliver bulk power over long distances. Despite all of

these drivers for change, transmission line designs have remained relatively unchanged over the last 40 years. Until now."

(T&D World, October 2015)

As of the publication of this paper, AEP is moving forward with more BOLD deployments. A second BOLD line using lattice towers was energized in July 2017 near Lafayette, Indiana. The first 345-kV double-circuit application of BOLD is a nine-mile rebuild in northern Indiana, targeted for completion in June 2018. BOLD structures will also support a line rebuild in Ohio and are being considered for other projects across the AEP system, including a new transmission line for a windfarm in southern Texas.

Literature Cited

APLIC. Reducing Avian Collisions with Power Lines, The State of the Art in 2012. 2012.

Center for Rural Affairs, From the Ground Up: Addressing Key Community Concerns. 2013

T&D World, AEP's BOLD Response to New Industry Challenge. 2015