Planning and Developing Electric Transmission Projects

THE PATH TO THE GRID OF THE FUTURE

Edison Electric INSTITUTE

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INTRODUCTION

Electric transmission infrastructure is the backbone of the nation's energy grid today and will play an important role in facilitating the continued transition to the resilient, clean energy future. The transmission system also lowers the cost of delivering energy and helps to keep electricity affordable by optimizing the energy grid's performance, reducing congestion, enabling the deployment of new technologies, and enhancing reliability and resiliency. Going forward, additional transmission investment and development will be needed to meet the demands of the future energy grid and the clean energy economy, as well as to maintain the reliability and resilience of the grid against increasing security threats and extreme weather events. According to a study by Princeton University, to achieve a zero-carbon future by 2050, the country's existing high voltage transmission capacity will need to expand by approximately 60 percent by 2030 and triple compared to 2020 capacity through 2050 to connect anticipated wind and solar resources. Further, total capital investment in transmission will need to reach $360 billion through 2030 and $2.4 trillion by 2050.[1]

EEI's member companies—America's investor-owned electric companies—are vital to transmission development and will play an important role in this transition. They are committed to getting the energy they provide as clean as they can as fast as they can, without compromising on the reliability and affordability that are essential to the customers and communities they serve. Each year, EEI's members invest more than $110 billion, on average, to make the energy grid stronger, smarter, cleaner, more dynamic, and more secure while working to ensure that customer rates remain just and reasonable. To continue serving customers reliably and cost-effectively while addressing the challenges of the future grid, EEI member companies invested $25 billion in transmission infrastructure in 2020 and an estimated $27.8 billion in 2021.[2] By exercising cost discipline in building transmission facilities—for example, through competitive solicitations for equipment, construction, and labor—electric companies are able to provide cost-effective transmission solutions.

Despite the importance of electric transmission, the complexity of transmission development is often overlooked or not fully understood. It is essential that state and federal regulators have a full picture of the transmission development process and how their policies can foster more efficient and cost-effective transmission development.

In order to provide greater insight into the transmission development process, this paper provides several examples, as submitted by EEI member companies, that trace transmission projects from conception to completion, including the unexpected challenges that sometimes arise, and the innovative solutions developed to address these challenges.

1 E. Larson, C. Greig, J. Jenkins, E. Mayfield, A. Pascale, C. Zhang, J. Drossman, R. Williams, S. Pacala, R. Socolow, EJ Baik, R. Birdsey, R. Duke, R. Jones, B. Haley, E. Leslie, K. Paustian, and A. Swan, *Net-Zero America: Potential Pathways, Infrastructure, and Impacts*, interim report, Princeton University, Princeton, NJ, p. 106 (Dec. 15, 2020).

2 Edison Electric Institute, Business Analytics Group, Historical and Projected Transmission Investment (Dec. 2021); https://www.eei.org/resourcesandmedia/Documents/bar_actual_and_projected_trans_investment.pdf

Planning and Developing Electric Transmission Projects: The Path to the Grid of the Future

CASE STUDIES

AMERICAN ELECTRIC POWER (AEP)

The Charleston Area Improvements Project

American Electric Power (AEP) is one of the largest electric companies in the United States, delivering electricity to more than five million customers in 11 states. AEP's service territory covers approximately 200,000 square miles in Arkansas, Indiana, Kentucky, Louisiana, Michigan, Ohio, Oklahoma, Tennessee, Texas, Virginia, and West Virginia. It owns, operates, and maintains approximately 40,000 circuit miles of transmission lines, including more than 2,100 circuit miles of 765-kilovolt (kV) transmission.

PROJECT DETAILS

Need

One usually pictures a transmission project as a long new line stretching across a wide geographic area. In reality, a project often involves a cluster of related work combined to address the needs of the network that powers a local community. AEP's Charleston Area Improvements Project is a great example of this type of project.

Appalachian Power, a subsidiary of AEP, identified multiple aging equipment failures on its 46-kV underground transmission system in Charleston, West Virginia, in 2014. As crews examined and repaired these failures, they identified system conditions that placed the system serving the state's capital city at risk. To reduce the likelihood of failures, the company coordinated with the city and installed a temporary overhead transmission line to connect two 46-kV substations in downtown Charleston. Although the temporary transmission line addressed many of the short-term outage concerns on the existing system, it did not address other long-term risks including potential overload conditions that could severely tax the system.

Solution

The Charleston Area Improvements Project provided a long-term solution to ensure reliable electric service. The transmission and distribution improvements in operation today provide sufficient energy capacity for growth in and around the capital city's area.

The project included:

- Building approximately 5 miles of double-circuit 138-kV transmission line;
- Building approximately 1 mile of 46-kV transmission line;
- Installing about one-half mile of under-

ground 138-kV transmission line beneath Interstate 77 and through the downtown area;

- Building a new Bullitt Street Substation in downtown Charleston;
- Expanding and upgrading the existing Capitol Hill, Chesterfield and Washington Street substations;
- Making related upgrades to the local distribution system; and
- Retiring the Brooks Street Substation.

Planning

Preliminary project cost estimates were approximately $80-100 million. The project required an expedited schedule so crews could de-energize the temporary 46-kV transmission line by August 2019, the expiration date for a five-year temporary easement for the line.

The project posed multiple obstacles, such as:

- A congested and constrained downtown area;
- Challenging terrain surrounding the city;
- The need to cross the Kanawha River, which required permitting from the U.S. Army Corps of Engineers (USACE);
- Building an underground line beneath a major interstate highway;
- Building a new substation and expanding an existing substation in an urban area;
- Navigating around other underground infrastructure, vital businesses, and government services; and
- Mitigating practical environmental and visual impacts.

Outreach

AEP knew the work would disrupt area residents and businesses. The company wanted to ensure that, before any work started, the community understood the process, why the work was necessary and what to expect during construction. AEP did extensive outreach to educate and engage the local community and affected property owners.

The company launched a project website to provide detailed maps and information, and to solicit community input. AEP sent direct mailings to property owners in the project area and hosted a public open house in June 2015 to gather information and share details about the proposed improvements. In addition, the company hosted several smaller meetings with individual property owners and homeowner associations. The company hosted meetings with county and city agencies before and throughout construction and coordinated extensively with local officials and stakeholders to address their concerns.

Per West Virginia regulatory requirements, AEP also submitted a public notice of the project in local newspapers in more than 15 West Virginia cities noting the cost of the project and estimating that customer retail rates would be impacted by an estimated $0.06954 per 1,000 kWh per month. In other words, this $100 million transmission project that provides considerable reliability benefits would cost the average customer about six cents per month. The notice further provided instructions for intervening in and/or protesting the permitting of the project before the West Virginia Public Service Commission.

The company's extensive outreach effort provided residents and business owners with a first-hand look at project plans and an opportunity to share feedback to help the company design and build a better project. This robust effort represents AEP's best practices when building transmission projects in communities across its footprint.

Figure 1: AEP public meeting; courtesy of AEP.

Permitting

The project required typical storm water permits, in addition to the USACE River Crossing Section 10 Permit. The river crossing also involved crossing the entrance ramp to I-64, four lanes of Route 60 and four lanes of I-64 in addition to CSX railroad tracks and distribution lines. This required extensive coordination with the state's department of transportation, the railroad company, and the city.

AEP submitted an application on November 25, 2014 for a Certificate of Public Convenience and Necessity with the West Virginia Public Service Commission for the Charleston Area Improvements Project detailing the project need, project specifications, estimated costs, financing, estimated time for completion and estimated impacts on customer retail rates.

Several local homeowners filed a petition on January 28, 2016 to intervene, concerned about the impacts of expanding and upgrading one of the area substations. The intervention noted that the current substation, located in a residential neighborhood, would be significantly expanded and was of a different nature and character from most of the single-family homes in the neighborhood. In addition, the expansion of the substation would cause the resulting structure to be directly adjacent to the interveners' properties. According to the petition, it could not be determined whether AEP conducted noise testing to determine impacts on background noise, whether the project was safe from fire and explosions, and whether there were health concerns given its proximity to residences. Considering the compressed construction timeline of 36 months, interveners also were concerned about construction noise, debris, and the hours of construction. Finally, interveners raised the potential that visual impacts of the expanded substation may affect property values.

AEP was able to successfully work with the interveners and a Joint Stipulation and Agreement for Settlement was filed on May 11, 2016 with the West Virginia Public Service Commission stipulating that construction of the substation in contention would occur Monday through Friday between 7 a.m. and 5:30 p.m. The West Virginia Public Service Commission approved the Joint Stipulation and Agreement for Settlement on June 24, 2016 and granted AEP its Certificate of Public Convenience and Necessity.

The company successfully mitigated the visual impacts of the substation by agreeing to build an architectural brick wall around the substation expansion that was similar in character to the adjacent townhomes (see Figures 2 & 3).

Figure 2 (top): Substation design to match neighborhood character; courtesy of AEP.

Figure 3 (bottom): The substation as built, demonstrating the fidelity of the final product to the design in Figure 2, above.

Design, Procurement, and Construction

AEP leveraged its buying power to ensure a competitive process for materials and contract labor when building the Charleston Area Improvements Project. The company's procurement team includes specialists who managed the purchase of materials and services for the project.

AEP utilizes a rigorous, fact-based strategic sourcing process, which focuses on the lowest total cost of ownership, as a component of AEP's larger procurement organization.

The procurement process begins with vetting potential vendors and service providers. Critical to that is having well-established relationships, clear expectations, proper inspections, and solid results metrics. Other success factors include effective market analysis and communication in resolving emergent issues.

- AEP Engineering Standards and Procurement groups procure all materials and equipment from vetted, tested, and approved vendors.
- Vendors are qualified through a rigorous process of interviews, facility inspections, material testing, and piloting.
- Approved vendors continue to be inspected, tested, and piloted for new processes and products to remain in good standing.

AEP Procurement closely aligns with the company's Supplier Diversity team, economic development, and business partners to maximize opportunities for small and diverse businesses to participate in sourcing events with a goal to achieve a 15 percent diverse spend by 2025.

Company-approved contractors competitively bid to build the project. The company also agreed to use a local brick masons union to complete the brick wall construction. Construction of the Charleston Area Improvements Project began in the summer of 2017. The work on the power lines and substations proceeded in parallel to complete the project by December 2019.

AEP used multiple mitigation measures to minimize impacts on the local community, including:

- Transformers were located on the end of the substation away from the interveners' townhomes, and special attention was given to equipment location.
- Firewalls were installed between each transformer to enhance the safety of the equipment's operation and reduce transformer noise.
- The expansion and upgrade plans were designed to ensure noise levels would not differ from existing levels at the substation and in surrounding areas. Additionally, AEP planned to evaluate noise levels in the future and identified multiple options to mitigate future noise levels if they prove problematic.
- The substation steel design was customized from 50 feet to 37.5 feet, resulting in a reduction of the upgraded substation's overall height.
- With input from neighboring residents and other members of the community, AEP agreed to build an architectural brick wall between the town homes and around the substation expansion and installed landscaping in the intervening space. The wall was designed to complement the facade of the townhouses and to include security lighting that matched similar equipment in the townhouse development.
- A seven-foot strip of property was leased to the local homeowners' association bordering the four units closest to the expansion, thereby increasing the depth of neighboring residents' yards.
- Temporary noise and dust were mitigated during construction to the extent practical. For example, AEP adopted time-of-day and dust control practices in coordination with the local homeowners' association.
- At the new substation located adjacent to downtown businesses, the company agreed to build another brick wall to screen the substation and a lighted parking lot area adjacent to the substation for the local businesses.
- Retiring the Brooks Street Substation required extensive underground distribution work. All underground circuits were relocated across town to the Washington Street Substation to ensure continuous reliability to customers.

AEP was sensitive to the community throughout construction and took numerous additional steps to minimize the project's impacts. Here are just a few examples of how AEP worked with businesses and other entities:

Transmission line construction took place behind the Charleston Area Medical Center's Cancer Center. The company had contractors remove and place all memorials in storage for protection during construction. After construction was completed, landscapers returned the memorials and returned the memorial garden to its previous condition.

The parking lot located at the medical facility's training center had to close for two weeks during construction. AEP leased a remote parking lot and hired shuttle buses to transport employees to and from the training center safely.

The line route was located next to a cemetery listed on the National Register of Historic Places. Construction crews accessed the site from the cemetery and, after completing construction, the company made improvements to the road and other areas near the cemetery.

Extensive coordination with CSX Railroad was necessary because about a mile of the double-circuit transmission line was located in the railroad's right-of-way easement. AEP created drawings detailing the location of equipment (bucket trucks, cranes, swing radius, equipment specs, etc.) for each structure placed on railroad property. As an extra safety precaution, a railroad flagman was on site throughout construction.

The project was completed and energized in December 2019 at a total cost of approximately $100 million**.** With good planning and extensive coordination, environmental and community impacts and costs were minimized. Additionally, impacts were generally temporary (construction related), and the company's mitigations helped address many of the residents' concerns in a reasonable and cost-effective manner.

EVERSOURCE ENERGY

Greater Hartford Central Connecticut Reliability Project

Eversource is New England's largest energy delivery company, safely and reliably delivering energy to approximately 4 million electric and natural gas customers in Connecticut, Massachusetts, and New Hampshire. Eversource manages nearly 2,300 miles of transmission corridors with investment in the transmission system from 2019-2023 expected to be approximately $3.35 billion. Eversource's high-voltage electric transmission system plays an essential role in connecting customers across New England with reliable and affordable power, while also enabling a clean energy future. Eversource's investments in transmission help ensure that the energy grid will be able to integrate a growing number of clean energy resources and meet an increased demand driven by electrification, while maintaining reliability and resiliency to extreme weather events.

PROJECT DETAILS

Need

Electric system planning studies conducted by ISO New England (ISO-NE) in 2005 and 2011 identified potential reliability violations in the Greater Hartford, Connecticut area as well as the need to move additional power across Connecticut when the system is under stress.

Solution

The Greater Hartford Central Connecticut Reliability Project connects two load pockets (see Figure 4) in need of additional flexibility when the electric system experiences stressed conditions. The project included a new approximately 3.7-mile 115-kV transmission line from the existing Newington Substation in the Town of Newington to the Southwest Hartford Substation in the City of Hartford. The transmission line consists of two underground cable segments totaling 1.3 miles and one overhead line segment of 2.4 miles located along an Amtrak railroad right-of-way. The project also consisted of related upgrades at the Newington and Southwest Hartford substations (see Figure 5).

Planning

The project was the product of more than ten years of planning studies. In 2005, ISO-NE identified potential operating criteria violations on the 115-kV system in the Greater Hartford area. Accordingly, potential solutions initially considered for the regional problems in 2006 included improvements to the Greater Hartford 115-kV system, principally a new 115-kV line between Eversource's East Hartford and Manchester substations.

However, by 2009, further analyses showed that there were additional "load serving" issues in the Greater Hartford area that would not be resolved by a new 115-kV line. Therefore, in early 2010, ISO-

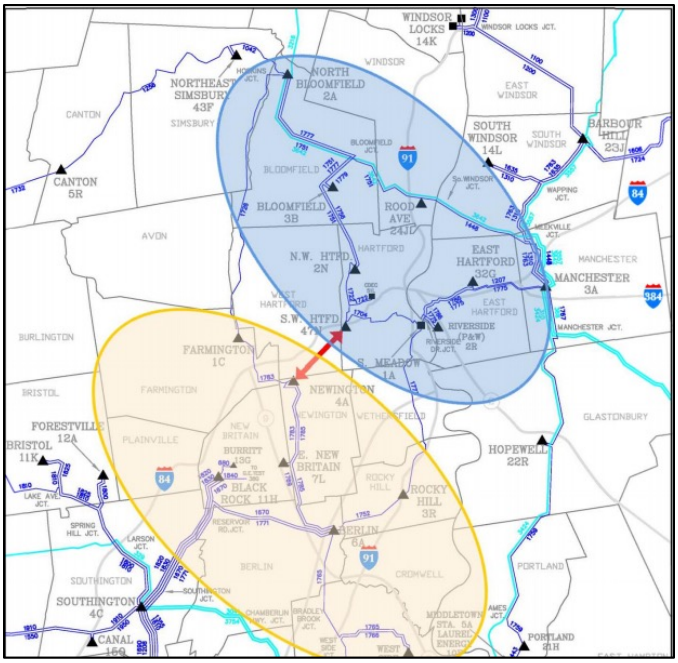


Figure 4: Load pockets in Greater Hartford sub-area and 115-kV Transmission Line Connection; courtesy of Eversource.

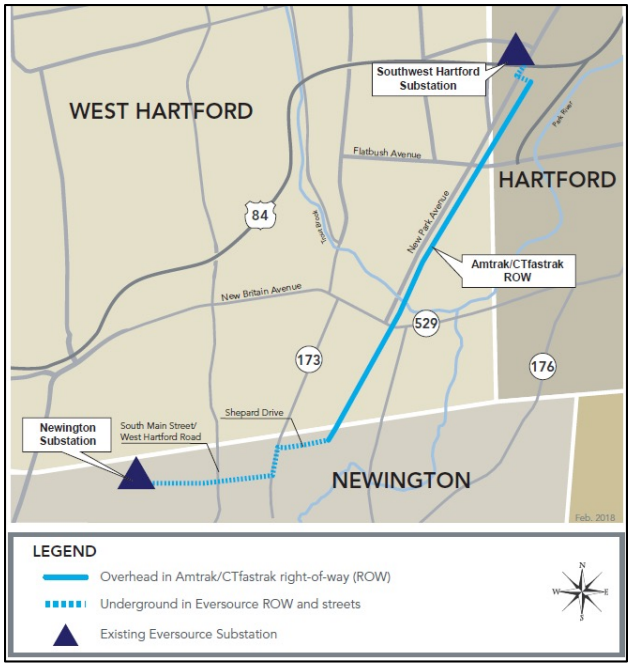


Figure 5: Greater Hartford Central Connecticut Reliability Project route map; courtesy of Eversource.

NE initiated a new separate study that took a comprehensive fresh look at the Greater Hartford area 115-kV system issues and sought a cost-effective solution for all of the identified problems in the area.

In early 2011, ISO-NE combined this study, along with other ongoing studies of reliability issues in sub-areas adjacent to Greater Hartford, into an assessment of load serving problems in four contiguous electrical sub-areas of Connecticut. To conduct this study, ISO-NE formed a working group consisting of transmission planners from ISO-NE, Northeast Utilities (now Eversource Energy), and The United Illuminating Company (now Avangrid Networks). The result of the study became the Greater Hartford Central Connecticut suite of projects.

The cost of the project was initially estimated to be approximately $91 million, with an approximate in-service date in the fourth quarter of 2019. Because the project was located in a fairly dense suburban area near Hartford, Eversource originally received ISO-NE approval to build this project entirely underground within existing roadways. As the design progressed, Eversource discovered a more cost-effective alternative using a hybrid approach with some overhead construction along an existing rail corridor. The hybrid approach ultimately reduced the project cost by approximately 9 percent but required significant coordination with Amtrak.

Eversource considered several alternatives including:

- **No action**: Under this alternative, no new transmission facilities would be developed, and no improvements would be made to the existing electrical transmission system or to supply or demand resources in either of the two load pockets. This alternative was rejected because it would not correct violations of national and regional reliability standards and criteria.
- **Non-Transmission Alternatives**: As part of the examination of electric system needs in the Greater Hartford area, ISO-NE conducted studies to identify potential solutions that would not require expansion of the transmission system. These studies considered demand-side alternatives and supply-side alternatives in general, but did not determine the types of resources and technology that would be required to offset the need for transmission improvements. The ISO-NE studies also did not estimate the cost of non-transmission solutions compared to the cost of the transmission solution. Accordingly, Eversource engaged an expert consultant to perform a study considering the potential technologies that could deliver the requisite energy injections to satisfy the reliability needs of the local areas, the

associated costs of these technologies, and the practical feasibility of each least-cost non-transmission solution. The consultant's study determined that non-transmission alternatives to the proposed project would be both more costly and impractical.

Outreach

Beginning with municipal briefings and community outreach about the planning and siting stage of the project, Eversource was committed to engaging stakeholders to inform, answer questions, and listen to concerns about the project. Eversource made significant efforts to provide notice of the project to stakeholders in the affected communities, including municipal officials, property and business owners abutting the proposed Project route, Chambers of Commerce, business organizations, land trusts, environmental groups, trail organizations, and historic preservation groups.

Starting in March 2015, Eversource consulted federal and state agencies about project impacts and mitigation on its original all underground design. Subsequent to this initial outreach, the company decided to explore a hybrid design, leveraging use of an existing linear corridor occupied by both an Amtrak railroad right-of-way and the state's rapid transit busway, CT*fastrak.* The company consulted with both the Connecticut Department of Transportation and Amtrak, and conducted extensive reviews with Amtrak on the design, providing detailed engineering information regarding the proposed collocation of the 115-kV line along the Amtrak right-of-way. Throughout these discussions, affected municipalities were also kept up to date on the design as it progressed.

Prior to filing the hybrid overhead/underground design with the Connecticut Siting Council (CSC), Eversource followed up with affected and interested stakeholders regarding the revised proposal for the Project. Briefings were held with municipal leaders and local business organizations, as well as abutting property and business owners along the proposed route.

In addition, Eversource held two public open houses on January 20, 2016 (on the original all underground design) and on April 27, 2017 (on the hybrid design). Notice of the proposed project was provided to each Eversource customer located within the municipalities of the 3.7-mile proposed transmission line route on a separate enclosure with each customer's monthly bill, as well as by mail and via door-to-door outreach by dedicated project outreach representatives. Where requested, personal briefings were held with property and business owners to review the proposed project and mitigate any anticipated impacts to the extent feasible. Eversource also maintained a dedicated project hotline, email address, and website throughout the extent of the project, from planning through restoration.

Permitting

On June 7, 2017, Eversource filed its Application for a Certificate of Environmental Compatibility and Public Need with the Connecticut Siting Council. After conducting several reviews and hearings, the Connecticut Siting Council issued a draft Finding of Facts on January 19, 2018 and granted the Certificate on February 1, 2018.

Design, Procurement, and Construction

Construction began in the fall of 2018.

The underground segments consist of a single-circuit 115-kV, solid dielectric crosslinked polyethylene (XLPE) cable. The XLPE cable is contained within polyvinyl chloride (PVC) conduits encased in a concrete duct bank. As part of the cable system, three buried splice vaults were required for interconnecting the cable sections and subsequently maintaining the underground portion of the 115-kV transmission line.

The overhead segment of the 115-kV line consists of 49 galvanized steel monopole structures, placed at intervals of approximately 250- to 300-feet along the Amtrak right-of-way and two galvanized transition structures (see Figure 6). The structures are approximately 95 to 110 feet in height above ground and arranged in a vertical configuration. All but one of the 49 transmission line structures are situated within the Amtrak right-of-way.

Some of the major challenges on the project included shifting the initial project design from entirely

Figure 6: Overhead transmission segment on the Amtrak ROW; courtesy of Eversource.

underground construction to a hybrid-design; significant substation expansion and reconfiguration; utilization of an existing distribution right-of-way for part of the new transmission line installation; land rights acquisitions on numerous properties; extensive coordination with the Connecticut Department of Transportation for work within state roads and with Amtrak Engineering and Operations on the design and construction detail for each structure location, as well as coordinating the complex construction logistics of working adjacent to an active rail line; and handling and disposition of approximately 25,000 tons of soil and rock. The construction team worked tirelessly to meet these and many more challenges, while also juggling the complications of addressing the COVID-19 pandemic while working in the field.

All materials and construction for the new line were procured through competitive processes to ensure the best value and minimize cost to the customer. The construction was broken down into five competitively bid scopes: underground civil, underground cable, Newington substation, Southwest Hartford substation, and the overhead. This approach minimized subcontractor markups and maximized the number of vendors able to provide bids on the work. Major materials, including the structures and conductor for the overhead scope, were purchased under competitively bid "blanket" procurements that allow Eversource to leverage buying power across all of the company's projects, thus minimizing the cost for any particular project.

The project was completed and energized on September 19, 2020, coming in under the initial estimates at total cost of $83 million. Restoration, including plantings at the switching station and substations, was completed in early November 2020.

ITC MIDWEST AND XCEL ENERGY

Huntley-Wilmarth Project

ITC Midwest, a subsidiary of ITC Holdings Corp., operates more than 6,600 circuit miles of transmission lines in Iowa, Minnesota, Illinois, and Missouri. The company is headquartered in Cedar Rapids, Iowa, and maintains operating locations in Dubuque, Iowa City and Perry, Iowa; and Albert Lea and Lakefield, Minnesota. To date, ITC Midwest has completed 35 new generator interconnections, adding approximately 4,410 megawatts of new generating capacity to the grid – including approximately 3,700 megawatts of wind energy production capacity. Over the past decade, ITC Midwest has completed more than 590 miles of 34.5-kV to 69-kV line rebuilds. This is part of ITC Midwest's continuing commitment to improve reliability of the electric transmission system and to serve the growing needs of customers in the region. These transmission line upgrades are enhancing grid efficiency, increasing the system's capacity, and reducing outages with the lines built to modern construction standards.

Xcel Energy is a major U.S. electricity and natural gas company, with operations in eight Western and Midwestern states. Xcel Energy provides a comprehensive portfolio of energy-related products and services to 3.7 million electricity customers and 2.1 million natural gas customers through its regulated operating companies. Headquartered in Minneapolis, Minnesota, the company is committed to serve customers with 100 percent carbon-free electricity by 2050. It also has an aggressive interim goal to reduce carbon emissions 80 percent by 2030 company-wide from 2005 levels. For the second year in a row, Xcel Energy has a record decline in carbon emissions for 2020, achieving a 51 percent reduction since 2005. It has demonstrated success with collaborative multi-company partnerships, like CapX2020 (the Capacity Expansion by 2020 partnership, a joint initiative of transmission-owning electric utilities in Minnesota and the surrounding region formed to expand the electric transmission grid to ensure electric reliability), that are unique in the industry.

PROJECT DETAILS

Need

The Minnesota and Iowa border is one of the most congested areas of the region's energy grid. The Midcontinent Independent System Operator (MISO) first identified the issue in 2008. As the use of and demand for electricity increased in following years, it became increasingly clear a solution was needed to not only ensure service reliability and resilience but also enable the delivery of new wind power to customers in both states. The Huntley-Wilmarth Project was jointly developed by ITC and Xcel to address these issues. The project was studied, reviewed, and approved by MISO's Board of Directors as a Market Efficiency Project (MEP) in December 2016. In early 2018, Xcel Energy and ITC Midwest submitted an application for a Certificate of Need for the project to the Minnesota Public Utilities Commission.

Solution

The 50-mile double-circuit Huntley-Wilmarth 345-kV transmission line connects Xcel Energy's Wilmarth Substation, north of Mankato, Minnesota to ITC's Huntley Substation, south of Winnebago, Minnesota. The Project is needed to relieve the current transmission congestion in this area and allow access to lower cost generation, reduce energy costs, strengthen the regional grid, and support future wind generation in Minnesota and Iowa. The project is jointly owned by the two electric companies. Permitting and implementation was led by Xcel Energy.

Planning

MISO's 2016 annual Transmission Expansion Plan (MTEP) report included information from a study conducted over more than 18 months and analysis of transmission system issues and evaluation of alternatives to determine the most effective transmission solutions. One of the goals of the MTEP process was to reduce the wholesale cost of energy delivery for the customer by identifying transmission projects that enable access to generation at the lowest total electric system cost under a variety of possible future scenarios.

MISO found, using the models and future assumption in the 2016 MTEP, that the Huntley-Wilmarth Project would provide $210 million in benefits on a net present value basis over 20 years and had a weighted benefit-to-cost ratio of 1.51 to 1.86. The MISO Board of Directors approved the Huntley-Wilmarth project in December 2016.

ITC Midwest and Xcel Energy also evaluated the economic benefits and cost estimates of the project under the system models and futures outlined in the MTEP for 2017. That analysis showed the projected benefits were even higher than MISO predicted in its earlier analysis since it reduces transmission system congestion, allowing lower cost generation to be used to meet customer demand and thus reducing the overall energy production costs.

Specifically, the analysis indicated the project would provide $246.3 million in saving benefits on a present value basis over 20 years and will have a weighted benefit-to-cost ratio of 1.64 to 2.14, depending on the route and design selected. The increased economic benefits were due, in part, to the increased amount of low-cost wind generation present in the MTEP17 futures enabled by Huntley-Wilmarth.

The initial route developed by MISO for the scoping level estimate was for a parallel, single-circuit configuration using the existing transmission right-of-way of the Wilmarth – South Bend 115 kV line from Mankato and the existing South Bend – Winnebago 161 kV line. This route is relatively short at 38.5 miles and utilizes an existing corridor. Xcel Energy notified MISO of concerns that the existing 115 kV right-of-way through Mankato would not be able to accommodate the clearance requirements for a new 345 kV transmission line and that this right-of-way could not be expanded. Based on this information, MISO worked with Xcel Energy to determine a more reasonable line length based on potential alternate routes for the project, resulting in MISO's selection of a longer route length.

Given the unique nature of the project, ITC Midwest and Xcel Energy proposed four route alternatives and several design options that yielded nine distinct route and design combinations. These options had total costs ranging from $118 million to $151 million (current year dollars). In addition to the routes proposed by the companies, the Minnesota Public Utilities Commission (MPUC) permitting process allowed local governments and individuals to offer alternative routes, resulting in routes with costs up to $167 million. The different design and route options enabled the MPUC to select an option that provid-

ed the appropriate balance between the economic-based need for the project while minimizing the project's potential impacts to the public and natural resources.

Developing routes to connect the two substation endpoints, Minneopa State Park and the communities of Mankato and North Mankato presented challenges to developing the shortest and most direct route. The existing Wilmarth Substation is located within the northern boundary of Mankato. To connect it to the Huntley Substation to the south, the companies developed two direct routes, as well as two routes that avoided the high-density areas by traversing either to the west or east of the Mankato/North Mankato area (see Figure 7), and three designs that balanced cost and land impacts, including single circuit H-frames, single circuit monopoles, and double circuit monopoles. Routes to the west of North Mankato were constrained by Minneopa State Park, which occupies roughly seven miles of the Minnesota River Valley west of the cities of Mankato and North Mankato.

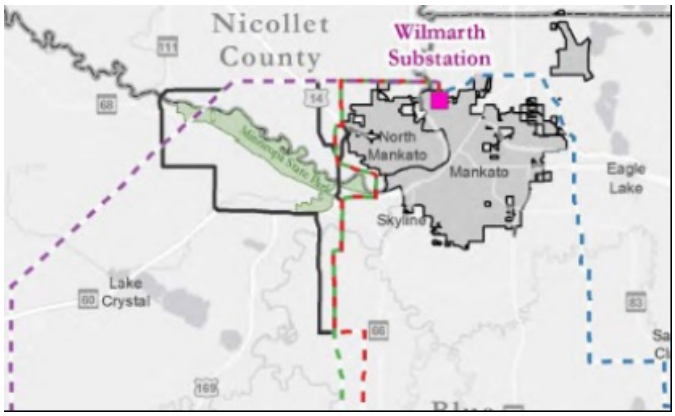


Figure 7: Diagram of route alternatives through an urban area for Huntley-Wilmarth Project; courtesy of Xcel Energy and ITC Midwest.

Outreach

Numerous public hearings and open houses were conducted to provide impacted communities the opportunity to review the plans, ask questions, and provide comments (see Figure 8). The companies have also maintained ongoing landowner communications throughout the project, including newsletters and a public website with project updates and contact information for questions and comments (see Figure 9).

Permitting

The Huntley-Wilmarth project required two approvals from the Minnesota Public Utilities Commission, a certificate of need and a route permit. On January 17, 2018, the application for a Certificate of Need was filed with the MPUC. The application for the route permit was subsequently filed on January 22, 2018. On May 22, 2019, an administrative law judge issued the Findings of Fact, Conclusions of Law, and Recommendation suggesting the MPUC grant the certificate of need and route permit. After several reviews and public hearings, the MPUC determined the project was needed and decided on the appropriate route on June 27, 2019 with the certificate orders issued on August 5, 2019.

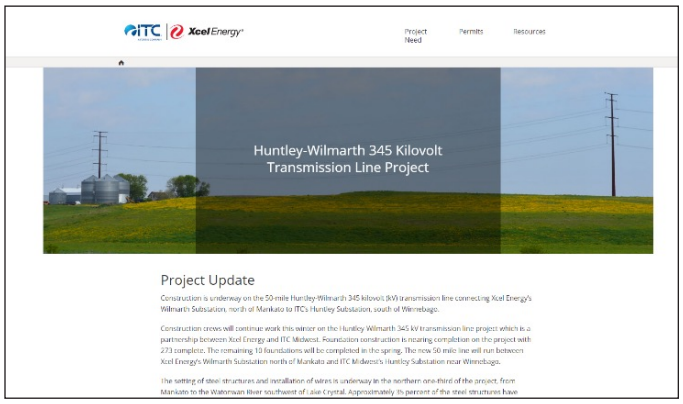
After the MPUC decision on an approved route, applicants began work to obtain other permits including from USACE. Authorizations from USACE were required to cross navigable waters, including two across the Minnesota River, and minimize impacts to wetlands. Xcel Energy applied to USACE in December 2019 and received authorization in July 2020 for all areas except for the northernmost eight structures where a cultural resource was discovered.

Field surveys of the approved route began after the MPUC route determination and continued through the spring of 2020. Archaeological surveys discovered an area of artifacts occupying approximately 2,000 feet of the approved route in an existing transmission corridor that was on a bedrock outcrop in the Minnesota River valley. Archaeologists theorized that the area was used as a quarry site to obtain materials for stone tool making, possibly going back thousands of years.

The approved route in this area required removal of an existing single-circuit transmission line to be replaced in the same corridor with new double-cir-

Figure 8 (top): Huntley-Wilmarth open house; courtesy of Xcel Energy and ITC Midwest.

Figure 9 (bottom): Huntley-Wilmarth website; courtesy of Xcel Energy and ITC Midwest.



cuit structures. Based on consultation between USACE and tribal representatives, the companies were able to minimize impacts to the cultural resources by altering the design of the project to place new structure foundations in the exact spot of removed foundations, thus minimizing disturbance to buried artifacts.

USACE coordinated with the State Historic Preservation Office. The permit was issued in June 2021.

Design, Procurement, and Construction

To reduce impacts to agriculture, the MPUC, in its permitting decision, selected a route and design alternative that utilized steel pole structures in a single monopole configuration. To further reduce agricultural impacts, the structures on the northern 22 miles are a double-circuit design to accommodate both the new 345-kV line and an existing transmission line. The 345-kV line has a right-of-way of 150 feet with structure heights from approximately 110 feet to 170 feet. The spans between structures average about 1,000 feet supported by an approximately 7- to 12-foot diameter, drilled pier concrete foundation. The project was designed by Xcel Energy's engineering staff. A helicopter was used for wire stringing and other operations, such as carrying lineworkers and transporting materials that permanently attached to conductor at most structures. The helicopter also reduced the amount of heavy equipment traffic along the project right of way (see Figure 10).

To maintain the development schedule, the project began preliminary design and easement preparations ahead of the MPUC decision.

Given the Huntley-Wilmarth project status as a MISO market efficiency project, ITC Midwest and Xcel Energy recognized the need to aggressively manage project construction, schedule, and costs to achieve the planned project cost-benefit outcomes. As incumbent electric companies serving the southern Minnesota region, ITC Midwest and Xcel Energy have taken several steps to achieve those goals and worked together seamlessly for the benefit of electric customers.

Figure 10: Helicopter installing transmission line and conductor; courtesy of Xcel Energy.

In spring 2019, it became apparent that the MPUC would likely approve one of two routes. The project conducted a helicopter-based LiDAR survey and performed preliminary design and structure spotting for both alternatives. In addition, the project began title research on parcels along the two likely route alternatives and hired a right-of-way contractor to assist with acquisition activities. These activities allowed the companies to begin acquiring easements along the approved 52-mile route in September 2019, one month after the MPUC order. Acquisition was substantially complete by May 2020.

Xcel Energy served as general contractor performing some tasks with its own construction crews and managing the contractor's work with a highly experienced team of construction managers, field inspectors, permit analysts, engineers, right-of-way personnel and project managers. Project-level competitive bid processes were held in late 2019 and early 2020 for major aspects of material and labor including steel structures, conductor, foundation construction, and transmission line construction. In addition, the companies used competitively bid alliance partners for additional engineering support and minor material vendors. These steps resulted in additional cost savings.

In May 2020, foundation work began with both contract crews and Xcel Energy construction crews. Overhead line construction began in September 2020.

Environmental and agricultural monitoring were also provided by Xcel Energy. In addition to the schedule challenges with the cultural finding near the Wilmarth substation, the project had to sequence work in other areas to avoid environmental impacts to rare birds, the northern long-eared bat, and rare plants. Even with these challenges, the project was energized on December 1, 2021; a month ahead of MISO's required in service date. As experienced incumbent transmission owners serving the southern Minnesota region, ITC Midwest and Xcel Energy were able to aggressively manage project construction, schedule, and costs to achieve the planned project cost-benefit outcomes. From a cost estimate of $155.7 million, the project's total cost was $118.3 million, saving customers money and continuing to demonstrate the ability of incumbent electric companies to cost-effectively develop and manage transmission projects.

CONCLUSION

Supporting Transmission Development for Our Clean Energy Future

EEI's member companies continue to invest in and develop the cost-effective transmission needed to meet federal, state, and company-level clean energy goals, while continuing to provide the affordable and reliable electricity that customers depend on. Despite the clear need for transmission to help the country achieve a clean energy future, challenges remain.

As demonstrated above, transmission development is a complicated process. Communication, coordination, and experience are essential to getting needed transmission infrastructure built in a timely and cost-effective matter. EEI members are responsible to their customers and have the in-depth technical expertise and knowledge of their systems necessary to make complex operations and development decisions. This experience and knowledge are necessary to make decisions that maximize the efficiency of their systems for the benefit of their customers.

To support the infrastructure development needed for the energy grid of the future, state regulators and the Federal Energy Regulatory Commission should continue to enact regulatory frameworks that incentivize investment at a level commensurate with the enormous task at hand. Policies that promote regulatory certainty and that address barriers to transmission development will play an important role in ensuring that needed transmission gets built to help the nation continue its clean energy transition.

The **Edison Electric Institute** (EEI) is the association that represents all U.S. investor-owned electric companies. Our members provide electricity for more than 220 million Americans, and operate in all 50 states and the District of Columbia. As a whole, the electric power industry supports more than 7 million jobs in communities across the United States. In addition to our U.S. members, EEI has more than 65 international electric companies, with operations in more than 90 countries, as International Members, and hundreds of industry suppliers and related organizations as Associate Members.

Organized in 1933, EEI provides public policy leadership, strategic business intelligence, and essential conferences and forums.

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Edison Electric Institute
701 Pennsylvania Avenue, NW
Washington, DC 20004-2696
202-508-5000 | www.eei.org