

# Smarter Energy Infrastructure: The Critical Role and Value of Electric Transmission



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## INTRODUCTION

The energy grid efficiently delivers affordable, reliable, and safe energy to homes, businesses, and communities. Electric transmission is a critical part of the energy grid and is about more than just delivering electricity. A robust transmission system enables electric companies to integrate more renewable energy resources and to deliver more clean energy to customers; enhances the reliability and resiliency of the grid; enables the deployment of new technologies; optimizes the grid's performance and lowers the cost of delivering energy by reducing congestion; and helps to keep electricity bills low for customers.

Electric transmission is essential to meeting customer energy needs today. It also is key to delivering the energy future that electricity customers want and expect.

This report highlights the critical role of electric transmission in the energy grid and outlines the benefits transmission provides for electricity customers. The report offers five case studies of electric companies' transmission projects, and it provides crucial data for policymakers and other key stakeholders as they make important decisions related to infrastructure, energy, and environmental policy.

## TRANSMISSION: THE BACKBONE OF THE ENERGY GRID

With every advancement in technology, Americans are more plugged in and more connected, using electricity in more ways than ever. Our ever-increasing dependence on electricity underscores the vital importance of the energy grid, which includes generation, transmission, and distribution, for our nation's security and prosperity and for the lives of all Americans.

Called the world's most complex machine,<sup>1</sup> the energy grid instantly delivers electricity where and when it is needed, safely and reliably. Electric transmission infrastructure is the backbone of the energy grid.

To ensure that they can continue to meet their customers' needs, EEI's member companies—the nation's investor-owned electric companies—invest more than \$100 billion each year on generation, transmission, and distribution, on average, to make the energy grid smarter, stronger, cleaner, more dynamic, and more secure.

This investment in smarter energy infrastructure is helping achieve a shared vision of a smart, secure, and increas-

ingly clean energy system that works to the benefit of all customers. Reaching the full potential of a modernized energy grid requires ongoing investment.

Electricity customers continue to benefit from these investments in smarter energy infrastructure and from policy decisions made over the past century that have enabled transmission to increase connectivity, provide greater reliability over wider areas, reduce costs for customers, and integrate more diverse and cost-effective energy resources. By connecting more customers to an increasingly diverse and dispersed range of energy resources, the transmission system helped foster societal, economic, and industrial changes across the country while delivering benefits to customers. For example, investments in the transmission system accommodated the rapid proliferation of household electrical appliances. Going forward, these investments and the ones we are making today will help to increase the integration of renewable resources, power the rapid increase of electric vehicles (EVs), and facilitate the adoption of a broad array of smart technologies to better serve our communities.

America's electric companies continue to introduce innovative transmission technologies, such as fiber optic communications, advanced conductor technology, enhanced power device monitoring, and energy storage devices in transmission projects. Continued investment and public policy support for electric transmission are needed to ensure that electric companies are able to provide access to clean energy, increase the reliability and resiliency of the energy grid, and reduce congestion so that lower-priced resources are able to meet customer needs now and in the future.

## THE BENEFITS OF ELECTRIC TRANSMISSION

### PROVIDING ACCESS TO CLEAN ENERGY

It truly is incredible just how dramatically our nation's energy mix has changed over the past decade. Today, more than one-third of our electricity comes from carbon-free sources (including nuclear energy and hydropower and other renewables), and another one-third comes from natural gas. And, since 2005, the percentage of renewable sources in the energy mix has quadrupled.

As electric companies continue to transition their generating fleets, their emissions are dropping significantly. At the end of 2017, the electric power sector's carbon dioxide (CO<sub>2</sub>) emissions were 28 percent below a 2005 baseline,

<sup>1</sup> See Phillip F. Schewe, *The Grid: A Journey Through the Heart of Our Electrified World* (Joseph Henry Press, 2006).

the lowest level since 1988 and lower than the transportation sector since 2016.

This impressive trend is expected to continue, as many EEI member companies have announced significant voluntary commitments to further reduce CO<sub>2</sub> by 2030 and 2050.

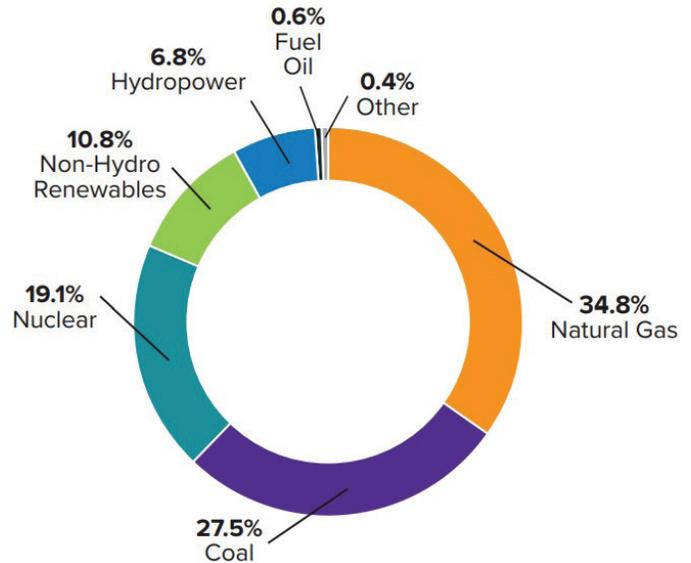
Electric transmission plays a vital role in facilitating the transition to clean energy by helping to integrate renewables into the energy grid. As renewable resources often are located far from the areas where energy is needed the most, investments in new high-voltage transmission facilities are needed to connect clean energy resources to the grid.

A changing energy mix can contribute to fundamental changes in how electricity flows on the energy grid, necessitating additional transmission capacity. For example, in the Electric Reliability Council of Texas (ERCOT) region, projected solar generation additions in western ERCOT, coupled with expected retirements of older power plants in eastern ERCOT, will increase west-to-east power flows, necessitating transmission system improvements to accommodate these changing power flows reliably.<sup>2</sup>

In addition, many states have set energy and environmental standards to help them transition to a cleaner energy future. For example, some northeastern states have set aggressive renewable energy goals, including the procurement of offshore wind. New York has a goal of 2,400 megawatts (MW) of offshore wind by 2030; New Jersey has a goal of 3,500 MW by 2030; and Massachusetts has a goal of 3,200 MW by 2035. Rhode Island and Connecticut do not have set MW targets, but they have contracted for 400 MW and 200 MW of offshore wind, respectively, in a 2018 competitive solicitation. Increases in the delivery of offshore wind will require significant transmission infrastructure for these coastal states.

A robust transmission system makes achieving these targets, as well as other environmental and public policy goals, not only possible, but less expensive and more efficient, by providing access to energy resources that may be located far from industrial centers. For example, Southern California Edison's Tehachapi Renewable Transmission Project is designed primarily to incent the development of renewable energy generation projects in remote areas of California by providing the connecting infrastructure for those resources to reach population-dense communities. As such, this project will contribute to meeting California's goal of serving 60 percent of customers with renewable resources by the end of 2030.

Figure 1 - U.S. Electric Generation Mix, 2018



Source: Department of Energy, Energy Information Administration

The risks associated with transmission investment, planning, siting, and construction, however, have not diminished, making smart public policy essential to ensure adequate transmission investment and development. To attract investment capital to deliver the benefits discussed above, regulators must provide predictable, sustainable, and reasonable returns to balance the risks inherent in such investments.

In addition, EEI has long supported legislative efforts at both the state and federal levels to minimize the regulatory challenges for permitting and siting of new infrastructure, including transmission assets. EEI continues to advocate for both legislative and regulatory approaches for reducing the time it takes for agencies to review permit applications. Because transmission projects often straddle multiple jurisdictions, the planning and siting process can be lengthy and complicated. Reducing these burdens responsibly will pay dividends for companies and customers alike by improving the capital flows needed to develop and improve critical infrastructure while avoiding the costs associated with lengthy permitting and siting proceedings.

## INCREASING RELIABILITY AND RESILIENCY

Electric transmission is essential to maintaining the reliability and resiliency of the energy grid. Resiliency is at the

<sup>2</sup> 2016 Long-Term System Assessment for the ERCOT Region, Executive Summary; [http://www.ercot.com/content/wcm/lists/89476/2016\\_Long\\_Term\\_System\\_Assessment\\_for\\_the\\_ERCOT\\_Region.pdf](http://www.ercot.com/content/wcm/lists/89476/2016_Long_Term_System_Assessment_for_the_ERCOT_Region.pdf).

core of transmission development and encompasses more than just the ability to recover quickly from serious weather events. The Federal Energy Regulatory Commission (FERC) cites the National Infrastructure Advisory Council's general definition of resilience as "the ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the ability to anticipate, absorb, adapt to, and/or rapidly recover from such an event."<sup>3</sup>

While there are various ways to define resilience, it becomes clear that the concept is based on a holistic approach to address dynamic and impactful risks to electric systems by anticipating, withstanding, recovering, and adapting to a wide variety of man-made or natural threats.

Protecting the nation's energy grid is our industry's top priority. It is estimated that electric companies have invested more than \$285 billion in transmission and distribution since Superstorm Sandy in part to harden the energy grid and make it more resilient. This includes investing in new and upgraded transmission and distribution infrastructure; using advanced technologies to enhance communications; improving operating efficiency and reliability; and enhancing protection to enable a more secure, flexible, and resilient electric system. For example, electric companies are upgrading their existing infrastructure to incorporate the latest hardening technologies. In many areas that are subject to high winds, flood waters, and hurricanes, electric companies are replacing wooden poles with more resilient and longer-lasting steel poles, while also raising existing substations above flood levels.

A robust transmission system can help prevent supply disruptions by enhancing access to varied generation sources and fostering system flexibility in the face of power plant retirements or unplanned outages. For example, during periods of low solar and wind output, the transmission system can deliver energy from other resources, including natural gas, hydropower, coal, and nuclear power plants.

Likewise, if one class of generation asset faces a fuel disruption or shortage, potential customer outages or impacts on the system can be mitigated with supply from other resources. For example, Minnesota Power is installing more than 200 miles of new transmission lines to bring carbon-free hydropower into Minnesota from Manitoba.<sup>4</sup> This transmission line will provide access to

resources with a unique combination of 24/7 supply characteristics, price certainty, and resource optimization flexibility. In another example, CenterPoint Energy's Brazos Valley Connection, energized in early 2018, installed new 345-kilovolt (kV) lines to connect to resources elsewhere in the ERCOT region to replace recent generation retirements in the Houston area.<sup>5</sup>

As the transmission system increasingly serves as a platform for the support and deployment of new technologies, significant complexity is added to the energy grid. This increasing complexity has, in turn, created new cyber and physical security, reliability, and resilience challenges. For instance, the industry is making significant investments to meet Critical Infrastructure Protection (CIP) mandatory reliability standards to mitigate against increasing cyber threats to the energy grid. Therefore, it is essential that electric companies are permitted to continue to make investments in protecting, building, maintaining, and enhancing the nation's electric transmission system. Similarly, regulatory certainty and policies favorable to transmission investment are critical.

Additional efforts to improve resilience include the industry-established Spare Transformer Equipment Program (STEP), SpareConnect, Grid Assurance, and the Regional Equipment Sharing for Transmission Outage Restoration program (RESTORE).<sup>6</sup> These complementary programs help electric companies access large transformers and other critical power restoration equipment in an emergency.

## ALLEVIATING COSTLY CONGESTION

While electric companies are making significant investments across the energy grid, electricity remains a great value. In 2017, for every dollar in consumer expenditures, less than a penny and a half went to pay residential electric bills—that's the lowest amount in nearly 60 years. And, transmission still comprises the lowest component of the average customer's electric bill.<sup>7</sup>

The integrated transmission grid and the industry's continued investment in transmission assets have helped keep those costs low for all customers in a number of ways, but none greater than through the alleviation of congestion.

The transmission system serves a vital role, similar to that of the nation's system of interstate highways. As roads can

<sup>3</sup> FERC, *Grid Resilience in Regional Transmission Organizations and Independent System Operators - Order Terminating Rulemaking Proceeding, Initiating New Proceeding, and Establishing Additional Procedures*, 162 FERC ¶ 61,012 at P 23 (2018).

<sup>4</sup> <http://greatnortherntransmissionline.com>.

<sup>5</sup> <https://www.brazosvalleyconnection.com>.

<sup>6</sup> For more on RESTORE, see [http://www.snow.com/news/business/local/article\\_50eb01ba-a858-11e7-88fe-b722fb337275.html](http://www.snow.com/news/business/local/article_50eb01ba-a858-11e7-88fe-b722fb337275.html). For more on STEP and SpareConnect, see <http://www.eei.org/issuesandpolicy/transmission/Pages/sparetransformers.aspx>. For more on Grid Assurance, see <http://www.gridassurance.com/>.

<sup>7</sup> U.S. Energy Information Administration, *Annual Energy Outlook 2019*, p. 97 (Feb. 2019).

become congested because new commercial and residential developments affect traffic flow, new sources of generation and changes in customer needs and load patterns can affect electricity flow and may lead to similar congestion issues, which creates costs. The U.S. Department of Energy (DOE), through its triennial congestion studies, has identified three types of congestion: (1) economic—preventing buyers of wholesale electricity from obtaining energy from the least-cost sellers; (2) reliability—rendering the system unable to meet North American Electric Reliability Corporation (NERC) reliability standards; and (3) public policy—hindering access to generation needed to meet local, state, and federal renewable and resilience goals.<sup>8</sup>

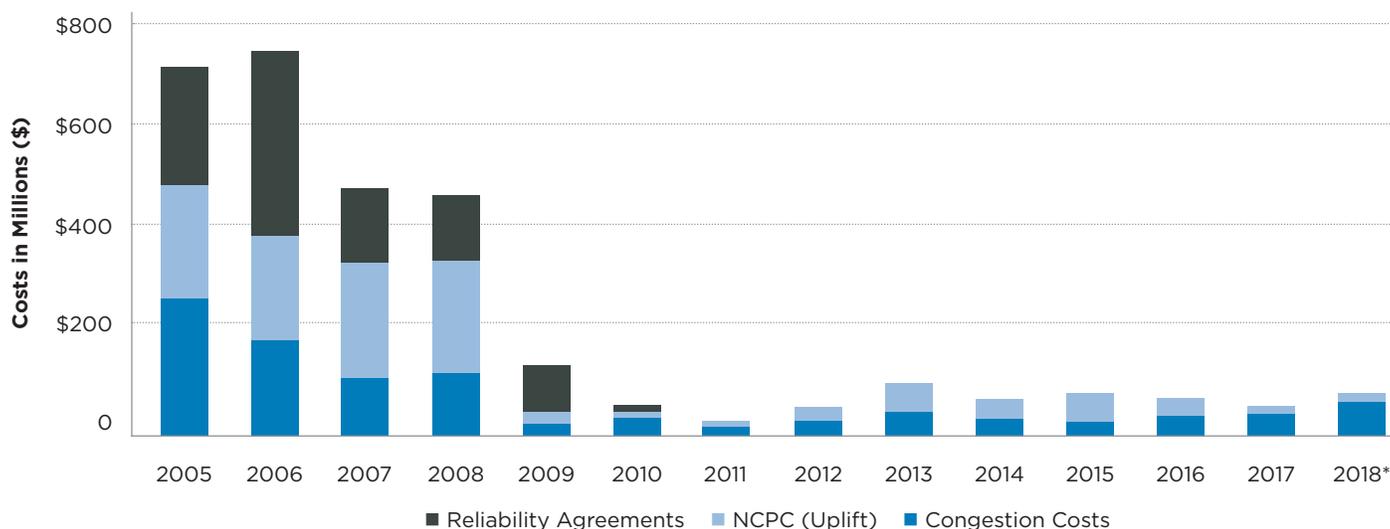
Electricity flows simultaneously over all transmission lines in the interconnected energy grid to areas with lower electrical resistance, so it generally cannot be directed to specific lines. In other words, there is no way to designate where electrons will go once they are placed on the system. As a result, generation and transmission operations in North America must be monitored and controlled in real time, 24 hours a day, to ensure a reliable and continuous supply of electricity to homes and busi-

nesses.<sup>9</sup> Without sufficient transmission to move electricity from where it is generated to where it is needed, the system can become congested, much like traffic congestion caused by insufficient highway infrastructure.

Electric transmission creates economic benefits and alleviates energy grid congestion by improving market liquidity, promoting price stability, and significantly reducing overall generation production costs, which ultimately will benefit customers.<sup>10</sup> Electric transmission optimizes efficiencies across a geographically and technologically dispersed energy portfolio to help minimize customer costs, transport clean energy, and mitigate system disruptions. This optimization can reduce energy consumption and also help to protect customers from rate volatility due to changes in fuel prices. Increased access to multiple generation resources creates additional market benefits, such as reduced overall risks on transactions and an increased diversity of financial products and services.

For example, in New England, transmission investments of \$10.6 billion over 20 years have reduced congestion and uplift costs for customers over the last decade (see Figure 2).<sup>11</sup> Uplift is an out-of-market payment that is

**Figure 2 - New England Costs for Congestion, Uplift, and Reliability Agreements**



Note: Congestion is a condition that arises on the transmission system when one or more restrictions prevents the economic dispatch of electric energy from serving load. Net Commitment-Period Compensation is a payment to an eligible resource that operated out of merit and did not fully recover its costs in the energy market. Reliability Agreements are special reliability contracts between the ISO and an approved generator whereby the generator continues to operate, even when it is not economical to do so, to ensure transmission system reliability. Sources: Regional System Plans, ISO-NE Annual Markets Reports. \*2018 data subject to adjustment.

<sup>8</sup> DOE, *Notice of Procedures for Conducting Electric Transmission Congestion Studies*, 83 Fed. Reg. 42647, (Aug. 23, 2018).

<sup>9</sup> NERC, *Understanding the Grid* (Dec. 2012).

<sup>10</sup> See e.g., Southwest Power Pool, *The Value of Transmission* (Jan. 26, 2016); <https://www.spp.org/value-of-transmission/>. SPP reports that adjusted production cost savings, resulting from transmission expansion during 2012–2014, totaled more than \$660,000 per day or \$240 million per year. See also, Midcontinent Independent System Operator, MTEP17 MVP Triennial Review, (Sept. 2017); <https://cdn.misoenergy.org/MTEP17%20MVP%20Triennial%20Review%20Report117065.pdf>. Decreases in congestion costs and increases in energy savings from the Multi-Value Projects create \$12.1 to \$52.6 billion in net benefits over the next 20 to 40 years with a benefit-to-cost ratio ranging from 2.2 to 3.4.

<sup>11</sup> ISO-NE, *State of the Grid: 2019*, slide 41, (Feb. 20, 2019), [https://www.iso-ne.com/static-assets/documents/2019/02/20190220\\_pr\\_state-of-the-grid\\_presentation\\_final.pdf](https://www.iso-ne.com/static-assets/documents/2019/02/20190220_pr_state-of-the-grid_presentation_final.pdf).

made to generators when a unit is dispatched out of merit (e.g., bypassing, for reliability reasons, a lower-cost unit). In many cases, the higher-cost unit is dispatched due to congestion on the transmission system, preventing the lower-cost resource from delivering electricity.

Transmission investments avoid uplift by reducing congestion. Reliability agreements, used to pay certain energy supply units to remain operational when they otherwise would retire until another solution can be put in place, are used to ensure adequate resources are available to maintain reliability.

However, additional work and investment still are needed in areas experiencing increased congestion. For example, according to PJM Interconnection LLC's (PJM) Independent Market Monitor, total congestion in the PJM region increased 145 percent in the first nine months of 2018 compared to the first nine months of 2017. The increase in congestion was attributable to high natural gas prices in the winter months and high oil costs for units needed to control for contingencies during transmission upgrades.<sup>12</sup> Similarly, in the Midcontinent Independent System Operator (MISO), real-time congestion increased 7.2 percent in 2017 compared to 2016 due to high fuel costs, extreme weather, and transmission outages due to upgrades.<sup>13</sup> By continuing to enhance the transmission system, access to lower-cost fuels, greater resilience, and alternate routing to mitigate outages will continue to lower congestion and potentially save customers money.

## ELECTRIC COMPANIES ARE INVESTING IN AMERICA'S ENERGY FUTURE

The transmission network provides optionality to meet the needs of customers and can enhance resilience while accommodating changing dynamics that impact the electric system. According to DOE:

[O]ne of the most strategically significant aspects of major new transmission projects that is seldom taken into account... is that transmission may serve multiple purposes over a long life—typically 40 years or more. That is, a well-designed transmission system enhancement will not only enable the reliable transfer of electricity from Point A to Point B—it will also strengthen and increase the flexibility of the overall transmission

network. Stronger and more flexible networks, in turn, create real options to use the transmission system in ways that were not originally envisioned. In the past, these unexpected uses have often proven to be highly valuable and in some cases have outweighed the original purposes the transmission enhancement was intended to serve.<sup>14</sup>

Transmission is about more than just delivering electricity—it is about providing value to customers by making an efficient, dynamic, and secure energy grid possible. From enhanced security and resilience, to providing a platform for smart technologies and renewable energy, the transmission system delivers a wide range of value and benefits to customers.

A significant part of the electric power industry's economic impact is attributable to transmission infrastructure development and upkeep. This spending has a significant impact on the economy through a variety of mechanisms, including direct spending; increased local, state, and federal tax revenue; employment; and indirect spending by construction and development crews.

National Grid's and Eversource's joint Merrimack Valley Reliability Project, for example, created approximately 1,000 jobs at the peak of construction and continues to yield significant annual property tax revenue along the project's route in Massachusetts and New Hampshire.<sup>15</sup> Central Maine Power's Maine Power Reliability Program created an average of 2,100 jobs per year during construction and injected more than \$1 billion into the region's economy.<sup>16</sup>

EI member companies are dedicated to prudent investment in needed and beneficial transmission infrastructure. Expansion and enhancement of the transmission system is needed to facilitate the development and integration of distributed energy resources, to integrate advanced clean energy technologies reliably and affordably, to connect renewable resources to the energy grid, and to ensure grid resiliency and reliability.

In addition, since a significant portion of the U.S. transmission system was built in the 1960s and 1970s, significant replacements and upgrades are required now, and in coming years, to maintain and enhance system performance. This is reflected in the fact that about a quarter of electric company transmission spending through at least 2021 is expected to be devoted to improving resilience and security, as well as to integrating advanced technologies.<sup>17</sup>

<sup>12</sup> Monitoring Analytics, Inc., *State of the Market Report for PJM: January through September*, pp. 63-65, (Nov. 8, 2018).

<sup>13</sup> Potomac Economics, *2017 State of the Market Report for the MISO Electricity Markets*, p. 53, (June 2018).

<sup>14</sup> DOE, *National Electric Transmission Congestion Study*, p. x (Sept. 2015).

<sup>15</sup> [https://d3n8a8pro7vhnmx.cloudfront.net/manhsolution/pages/22/attachments/original/1520609510/MVRP\\_One\\_Pager\\_v7\\_%2802.2718%29\\_%281%29.pdf?1520609510](https://d3n8a8pro7vhnmx.cloudfront.net/manhsolution/pages/22/attachments/original/1520609510/MVRP_One_Pager_v7_%2802.2718%29_%281%29.pdf?1520609510).

<sup>16</sup> <https://www.cmpco.com/OurCompany/MPRP.html>.

<sup>17</sup> Projected investment figures were obtained from the EEI Transmission Capital Budget & Forecast Survey supplemented with data obtained from company 10-k reports and investor presentations.

Transmission infrastructure investments deliver tremendous value to customers and always are made prudently with the customer in mind. Based on Energy Information Administration (EIA) data, on a nationwide average basis, transmission comprises just 13 percent of a customer's electric bill, or less than two cents per kilowatt-hour.<sup>18</sup>

As customer expectations evolve, EEI member companies are responding by adjusting their infrastructure priorities. The need for proposed new projects and the proposed investment may be reviewed in state siting proceedings and in prudency reviews by FERC. In addition, in markets operated by regional transmission organizations and independent system operators (RTOs/ISOs), proposed projects are reviewed by other stakeholders and by the RTOs/ISOs in a transparent process that provides for review, questions, and discussion.

For example, over the last eight years, MISO has evaluated a portfolio of regional transmission projects to determine the most cost-effective regional options to meet local energy and reliability needs. MISO's Multi-Value Projects represent the portfolio of chosen projects with an expected 1.8 to 3.0 benefit-to-cost ratio.<sup>19</sup> PJM's stakeholder process for transmission planning also is characterized by a significant degree of transparency with multiple opportunities for stakeholders to comment, seek data, ask questions, and even present their own project solutions and alternatives.

EEI member companies routinely participate in RTO/ISO competitive solicitations for projects that benefit customers through cost-effective, efficient, and innovative solutions to transmission needs. These competitive processes are reviewed extensively by the RTO/ISOs to ensure that the best transmission solutions are brought to fruition.

While transmission investment has remained robust over the last decade, this does not necessarily mean that all transmission infrastructure has been optimized. As investment data is aggregated nationally, it does not reflect specific areas with evolving transmission needs. And, as with the highway system, regular upgrades and maintenance are critical.

## **INVESTMENTS ARE BEING MADE TO REFLECT THE RAPID PACE OF TECHNOLOGY AND TRANSPORTATION ELECTRIFICATION**

A significant portion of electric company transmission investment is dedicated to enhancing existing infrastructure to meet customers' evolving needs and expectations. Electric companies are ever cognizant of utilizing their existing infrastructure and making cost-effective investments to ensure reasonable costs for customers. However, much of the energy grid infrastructure in existence today was built for a population that is much different than today's connected society, and continued investment will be needed to upgrade the system to continue to meet customer needs and expectations. For example, American Electric Power (AEP) estimates that nearly 11,000 line miles and 400 transformers, representing a third of AEP's transmission infrastructure, will exceed their life expectancy in the next 10 years.

The rapid pace of transportation electrification is a prime example of changing technology and customer expectations.<sup>20</sup> As shown in Figure 3, there are more than 1 million electric vehicles (EVs) on the road today. According to a joint study by EEI and the Institute for Electric Innovation, 18.7 million EVs are expected to be on the road in the United States by 2030.<sup>21</sup> The energy grid is a critical enabler of widespread transportation electrification.

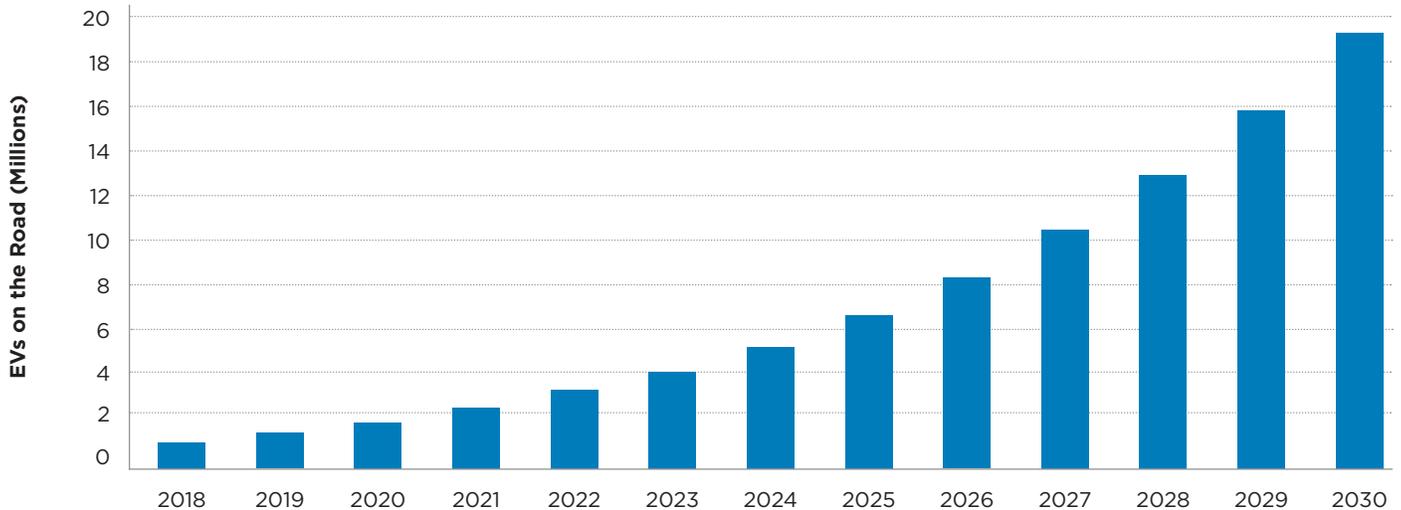
<sup>18</sup> EIA, Annual Energy Outlook 2019, p. 97 (Feb. 2019).

<sup>19</sup> MISO Transmission Expansion Plan (MTEP16) at p. 45; [https://www.misoenergy.org/Library/Repository/Study/MTEP/MTEP16/MTEP16%20 Full%20 Report.pdf](https://www.misoenergy.org/Library/Repository/Study/MTEP/MTEP16/MTEP16%20Full%20Report.pdf).

<sup>20</sup> See, e.g., Georgia Ports Authority, <http://gaports.com/about/sustainability/reducing-emissions>. See also, American Electric Power's Smart Columbus, <http://www.aepsustainability.com/energy/innovation/open/smart-city.aspx>.

<sup>21</sup> Electric Vehicle Sales Forecast and the Charging Infrastructure Required Through 2030 (Nov. 2018); [http://www.edisonfoundation.net/iei/publications/ Documents/IEI\\_EEI%20EV%20Forecast%20Report\\_Nov2018.pdf](http://www.edisonfoundation.net/iei/publications/Documents/IEI_EEI%20EV%20Forecast%20Report_Nov2018.pdf).

**Figure 3 - EEI/IEI Stock Forecast (2018-2030)**



### **INVESTMENTS TARGETING AREAS OF LOAD GROWTH AND CUSTOMERS’ INCREASED DEPENDENCY ON ELECTRICITY**

According to EEI estimates, around one-third of electric company transmission investment anticipated through 2021 is dedicated to transmission expansion or new construction.<sup>22</sup> A key driver of investment in grid expansion is meeting increased demand in areas of surging economic activity. Although U.S. electricity demand growth, generally, has slowed in recent years, some geographic areas have experienced a surge in economic activity resulting in increased electricity demand.

For example, oil and natural gas production from the Permian Basin in West Texas has increased the economic activity in that region, with companies investing billions in land acquisitions and extraction activity, which has led to a 50-percent increase in new home construction.<sup>23</sup> This comes on top of the continuing increase in integration of renewable energy into the Texas electric market made possible in part through the 2009-2013 Competitive Renewable Energy Zones (CREZ) program. As a result of the surge in demand and the accompanying economic development, Oncor is in the process of developing several transmission projects in the region.

In the East, the Utica and Marcellus shale gas boom in Ohio and West Virginia has the potential to increase AEP’s load by nearly 1.6 gigawatts (GW) in 2019, an amount representing about 35 percent of the existing load for central Ohio. Because these are largely rural areas, existing transmission infrastructure currently cannot handle substantial customer load growth. Thus, AEP is working to expand its transmission infrastructure to interconnect customers planning to build industrial-sized natural gas processing plants.<sup>24</sup>

There has been significant targeted load growth in the Northeast as well. For example, New Jersey is experiencing a resurgence of growth in some of its urban areas, including Jersey City and Newark, with electric demand reflecting that growth. In response, PSEG has invested significantly in its transmission infrastructure while keeping customer rates relatively stable.

In the technology sector, Northern Virginia is a hub for data centers given its proximity to government, population centers, and existing infrastructure. The number of data centers in the community of Ashburn, served by Dominion Energy, has grown 76 percent since 2013. Currently, Loudon County, Virginia has 4.7 million square feet of commissioned data center space, representing 955 MW of commissioned electricity. Dominion expected to deliver 1 GW of electricity to Northern Virginia’s data centers beginning in late 2018.<sup>25</sup> In order to meet this

<sup>22</sup> Projected investment figures were obtained from the EEI Transmission Capital Budget & Forecast Survey supplemented with data obtained from company 10-k reports and investor presentations.

<sup>23</sup> E. Scheyder, “As oil recovers, U.S. firms descend on the Permian Basin in West Texas,” Reuters (Feb. 1, 2017); <https://www.reuters.com/article/us-usa-oil-permian-insight/as-oil-recovers-u-s-firms-descend-on-the-permian-basin-in-west-texas-idUSKBN15G3F6>.

<sup>24</sup> <https://www.aep.com/about/transmission/TransmissionHighlights1.aspx>.

<sup>25</sup> R. Miller, “Northern Virginia Data Center Market Approaches 1 Gigawatt,” Data Center Frontier (Nov. 12, 2018) <https://datacenterfrontier.com/northern-virginia-colocation-market-us/>.

increased demand for electricity, new transmission infrastructure must be built to bring needed energy resources to these locations.

The energy grid supports critical infrastructure sectors and essential services that customers rely on for powering our economy and protecting our national interests. Our reliance on electricity has increased exponentially over the last decade as we have evolved into a 24/7-wired society. Electric companies must continue to invest in the system to ensure delivery of reliable and increasingly clean energy.

## TRANSMISSION FOR THE FUTURE

Transmission is the lynchpin to ensuring a reliable, affordable, and clean energy grid, but ongoing investment is required to enable the increased flexibility, enhanced automation, and increased connectivity required to meet customer needs and expectations. America's electric companies are investing in transmission infrastructure to deliver ever-greater value and benefits to their customers.

In today's society, the value of smarter energy infrastructure is undeniable, and continued investment in the transmission system is imperative. Electric companies are making substantial investments in the transmission grid to meet current and projected local, regional, and national needs and to provide value to their customers.

A significant driver of new and increased investment is electric companies' commitment to innovation by adopting new technology into the design of their facilities to enhance communications, improve operations, increase security, and ensure more cost-effective delivery of electricity. Congress recognized the importance of deploying advanced technologies in the Energy Policy Act of 2005 (EPAct 2005), directing FERC to encourage the deployment of new technologies that increase the capacity, efficiency, or reliability of existing or new transmission infrastructure. Some of these technologies, as defined by Congress, include high-temperature lines, underground cables, fiber optics, advanced composite conductors, ultra-high voltage lines, energy storage devices, enhanced power device monitoring, and mobile transformers and substations.<sup>26</sup> Real-world examples of innovative transmission technologies are provided in the case studies highlighted in this report.

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<sup>26</sup> See Section 1223 of the Energy Policy Act of 2005, 42 USC 16422.



# Transmission Innovation and Investment Benefits Customers: Five Case Studies



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## Sorenson – Robison Park 345 kV/138 kV Line



AEP Indiana Michigan Transmission Company's Sorenson – Robison Park 345/138-kV transmission line in Fort Wayne, Indiana, is the first of its kind using AEP's Break-through Overhead Line Design (BOLD®) technology. This 22-mile line, rebuilt in the existing right-of-way, provides enhanced reliability by reducing low-voltage situations and overloaded lines in the area brought on by the retirement of a significant amount of fossil generation.

BOLD is a compact extra-high voltage line design. It features a single steel pole with two curved arms, combining a simple, elegant appearance with increased performance. Two BOLD circuits are supported symmetrically, with three phases of each circuit connected by an innovative arrangement of conventional V-string insulator assemblies into a delta configuration. Incorporating an expanded bundle design (conductor size, number of sub-conductors, and bundle diameter) results in higher surge impedance loading and higher efficiency, providing a cost-effective solution. These features allow the movement of larger blocks of power using either fewer or narrower rights-of-way corridors or existing rights-of-way. BOLD's streamlined profile and compact line configuration is well-suited for constrained corridors, making it an excellent option for populated areas that have significant electrical demand but limited space.

The project provides five times the current-carrying capability of the existing line, with a 33-percent reduction in line losses compared to traditional 345-kV designs (and 50-percent reduction compared to 138-kV designs). It resolves low-voltage and thermal overload concerns in Fort Wayne and ensures reliable service in the region. Ground-level magnetic fields at the edge of the right-of-way are reduced by 50 percent as compared to traditional 345-kV designs. Overall, 345-kV BOLD structure heights are 40 feet shorter than traditional 345-kV towers. These qualities have helped minimize environmental and aesthetic concerns for the area.

### PROJECT HIGHLIGHTS

- Builds a higher voltage line within the existing 138-kV right-of-way, enhancing system reliability.
- Moderates electromagnetic fields and audible noise effects at the ground level.
- Minimizes environmental impacts by using a low-profile single pole structure, occupying a smaller footprint.
- Protects the line from lightning strikes by using zero-degree shield angle.
- Provides an avian-friendly design, reducing nesting, collisions, and electrocutions.
- Addresses aesthetic concerns for both property owners and the general public with its simple, elegant structure design.

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A survey shows that marrying new technology with aesthetics enhances public acceptance, which potentially could reduce permitting and siting delays in some cases. After the first BOLD line was put in service in 2016, BOLD crossed the threshold from concept to proven design. The second BOLD 345-kV line, using latticed towers, was energized in July 2017 near Lafayette, Indiana. The third

138-kV BOLD line near Fort Wayne was energized in the summer of 2018, with several more in this area to follow. In addition, a 230-kV BOLD design is being tested at the Electric Power Research Institute's lab in Lenox, Massachusetts. AEP has launched BOLD Transmission, LLC, as a vehicle offering this technology to developers both nationally and internationally.

Since being energized in November 2016, the Sorenson – Robison Park line has met or exceeded performance expectations. The project won EEI's prestigious Edison Award in 2017 for "distinguished leadership, innovation and contribution to the advancement of the electric industry for the benefit of all." The BOLD design also won the 2017 National Association of Regulatory Utility Commissioners (NARUC) Innovation in Electricity Award and was the 2017 Grand Prize recipient of the CIGRE/KEPCO International Tower Design Award.

### ABOUT AEP

American Electric Power (AEP) is one of the largest electric companies in the United States, delivering electricity to more than 5.4 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.

System-wide the company owns approximately 40,000 miles of transmission lines, including more than 2,100 circuit miles of 765-kV transmission.



# Military Veteran Transmission Lineworker Training

AEP Transmission has implemented successfully a nationally recognized apprenticeship program for transmission line mechanics. In June 2017, the U.S. Department of Labor approved the AEP Transmission Technical Skills training program standards as meeting the National Standard of Apprenticeship, resulting in AEP journeyworker transmission line mechanics being recognized as a part of the National Apprenticeship System.

This recognition enables AEP transmission line mechanics who are U.S. military veterans (or who currently are serving in the National Guard or Reserve) to apply for GI Bill benefit programs. Journeyworkers are able to receive benefits, including a monthly housing allowance and a stipend for books/supplies, in addition to their AEP wages.

AEP has a long history of employing military veterans and remains committed to hiring and training veterans. Overall, 11 percent of AEP employees are military veterans. Military veterans are a good fit for many types of field positions because they have leadership experience and are goal-oriented, organized, disciplined, and adaptable. They also are excellent at working in a team and are accustomed to a wide range of conditions. In the near term, this apprenticeship program will help AEP fill an immediate need for 150 transmission field workers. Increasing the size of this critical workforce ultimately will help improve the overall efficiency of field operations while maintaining high levels of reliability and resilience.

AEP also is partnering with West Virginia University at Parkersburg to offer transmission line apprentices the opportunity to obtain an Associate of Applied Science (A.A.S.) Degree starting in January 2019.

## PROJECT HIGHLIGHTS

- Helps provide a pipeline for current and retired members of the military to obtain paid training in a high-demand, rewarding career due to the program's eligibility for GI Bill benefits.
- Helps fill an immediate need for 150 transmission field workers, whose hiring will improve reliability and resilience across the system.

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## Rainey-to-Corona Project



Con Edison is committed to maintaining its industry-leading reliable electric service to the 3.4 million customers it serves in New York City and Westchester, New York. Con Edison makes strategic investments in its system to make sure it provides reliable power on the hottest summer days when the demand for electricity is high.

The Rainey-to-Corona transmission line project in Queens and the high-technology features being installed along the 5.7-mile route are emblematic of this commitment. Advances in manhole and cable monitoring will provide Con Edison a new level of visibility into the performance of its system, which is a key to reliability.

The project will establish a 138-kV tie between the Rainey and Corona Substations through underground feeder cable installed via a trench-and-conduit system. The project is the result of careful analysis that showed Con Edison needed additional infrastructure to keep service reliable in certain neighborhoods in Queens.

The system will include equipment to measure cable temperature in real time. The amount of power that can be sent through a cable is limited by the cable's temperature. As power flows through a cable, the cable becomes hotter. If a cable becomes too hot, it will start to break down and eventually fail.

Historically, engineers and operators have relied on projected temperatures to determine how much power they can send through a cable system. Determining the condition of cable based on actual conditions, rather than projected ones, will allow operators to utilize the full capacity of the cables. In addition, Con Edison will install monitoring equipment to detect faults before they occur. This technology is particularly useful in monitoring the health of cable joints. Vibration from above-ground traffic and years of carrying power can weaken joints over time and cause failure.

Con Edison will use this project to pilot "intelligent manholes." Seventeen manholes will house multiple sensors, giving unprecedented visibility into

### PROJECT HIGHLIGHTS

- Real-time sensors will alert Con Edison operators to potential problems before they affect customers. The route and construction methods minimize inconvenience to drivers, residents, and businesses.

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the status of equipment. Sensors will alert Con Edison to conditions that could indicate equipment in need of repair. That way, Con Edison can make the repairs before equipment fails and affects service to customers.

Sensors also will:

- Detect water, methane, and heat in the manholes and alert Con Edison's operators to conditions indicating that equipment might need repair;
- Measure the impact heavy traffic has on joints, bolts, and the structure itself;
- Monitor cable expansion. Cable expansion and contraction can add up to sizable distortions that stress cable joints.

Con Edison also is installing security devices to detect tampering with equipment or unlawful entry into the underground structures.

In designing the project's route, Con Edison's engineers and planners sought to minimize inconvenience to drivers, residents, and businesses during construction. In a city as dense as New York, Con Edison faced numerous challenges in attempting to avoid major roads, schools, places of worship, and police and fire stations. The final route avoids all highway and railway crossings. Additionally, Con Edison has avoided employing horizontal drilling or other construction methods that would cause unnecessary disruption. These strategies are not technically flashy, but they showcase Con Edison's commitment to the public.

Con Edison also realizes the importance of clear, timely communications with the public. Representatives distributed fliers, placed ads in newspapers, and spoke to elected officials and other community leaders before construction began.

Construction has proceeded on schedule and the line is expected to be in service by the start of the summer of 2019.

## ABOUT CON EDISON

Consolidated Edison's regulated electric business consists of Consolidated Edison Company of New York (CECONY) and Orange & Rockland Utilities (O&R). Con Edison also owns a new subsidiary called Consolidated Edison Transmission, LLC that will focus on new transmission development.

CECONY's electrical service dates back to 1882, when founder Thomas Edison put into service the first central generating plant in Lower Manhattan. Today, the company provides electric service to the world's leading financial district, critical transportation systems, and top schools, hospitals, and laboratories. CECONY is also a leader in helping customers get access to clean energy, energy efficiency programs, smart appliances, and other products and services technology has made possible.



## Drones for Transmission Line Inspection



Con Edison is deploying unmanned aircraft systems (UAS), commonly called drones, to inspect transmission lines and to make sure trees and vegetation do not have the potential to make contact. The drone inspections are faster than traditional inspections and enhance worker safety.

Con Edison has used drones to inspect lines for several years and now is field testing them for vegetation management. Lineworkers guide the drone pilots as to what images to capture. Con Edison then downloads those images and data for analysis on a high-definition (HD) screen.

Past drone use in Con Edison's transmission line maintenance program has included vendor demonstrations performing multiple tower inspections on overhead lines in Pleasant Valley, New York where HD photography was used to capture tower defects. Drones also were used to perform visual inspections of dead-end structures, where a conductor is attached to towers, to identify areas where equipment may have been compromised following a conductor connection failure.

A number of task-specific drones will be utilized on pre-determined company-owned, right-of-way locations to capture data that includes detailed above-canopy photographic observation; tree health; tree/shrub identification and area; and various LiDAR (Light Detection and Ranging – a form of radar that uses lasers instead of radio waves) and mapping measurements, including tree-to-conductor and ground-to-conductor distances, maximum line sag, property line location, and more.

### PROJECT HIGHLIGHTS

- Provides aerial laser mapping to determine vegetation clearances.
- Generates HD images of forest canopy, improving the ability of technicians to evaluate the state of vegetation.

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## The Marshall-Blackstone Transmission Project



ITC Michigan reconstructed 34.5 miles of transmission line with higher-capacity 138-kV conductor to provide greater reliability to customers in southern Michigan. The Marshall-Blackstone transmission project begins in Marshall Township in Calhoun County and extends East, ending in Blackman Township in Jackson County. The project traverses a variety of landscape types, including farm fields, residential areas, and wetlands. The wetlands segment of the project presented significant

challenges for the crews working on it, and their innovative problem-solving demonstrated ITC's commitment to environmental stewardship.

When planning transmission projects, ITC includes environmental assessments for wetlands, threatened and endangered species, and other sensitive habitats. Using a proven approach to the challenge of crossing wetlands in a transmission project, ITC crews used timber mats to protect the surface, prevent soil erosion, and avoid sedimentation problems in the wetlands segment of this project.

The timber mats were approximately 4 to 6 feet wide, 16 feet long, and 1 foot thick, and weighed more than 2,000 pounds each. Making efficient use of 64,000 construction mats, in unforgiving terrain on a project 35 miles long, was a project within a project. The contractor constantly had to plan days ahead to ensure that the right mats, and the right heavy equipment to move them, were in the right place at the right time. Considerable effort was expended to ensure that mat idle time was minimized; when a mat had served its purpose at a particular point on the right-of-way, it was picked up and moved to its next point of use. Several different types of heavy equipment placed mats in succession to build a "mat road," and, in particularly wet areas, the mats were laid atop one another as many as 10 deep.

### PROJECT HIGHLIGHTS

- The higher-capacity 138-kV conductor provides greater reliability to customers in southern Michigan.
- The wetlands segment of the project demonstrated ITC's commitment to an ISO-14001-based environmental management system across its operations.
- ITC crews used more than 60,000 timber mats to protect the surface, prevent soil erosion, and avoid sedimentation problems in the wetlands segment of the project.

### ABOUT ITC

ITC Holdings Corp. (ITC) is the largest independent electricity transmission company in the United States. Based in Novi, Michigan, ITC invests in the electric transmission grid to improve reliability, expand access to markets, allow new generating resources to interconnect to its transmission systems, and lower the overall cost of delivered energy.



## Toll Road – Static Var Compensators



ITC undertook a study that examines Michigan’s Capacity Import Limit (CIL), or basically, how much generation capacity can be imported into the Lower Peninsula through transmission connections with Ohio and Indiana. Through the study process, ITC determined that, in order to import more power into Michigan, voltage issues must be addressed. That is, there currently is enough wire in the system to maintain or increase imports, but imports are limited by low-voltage constraints and will

become severely impaired when considering the recent generation retirements announcements for Michigan. To address this, ITC is evaluating an innovative solution based on proven technology—static var compensators (SVC)—that not only will allow for additional capacity to be imported, but also provide an operational tool to ensure voltage stability for a diverse set of system conditions. This means that more power can be transmitted reliably through the system over existing lines from a variety of generation sources.

ITC Michigan’s Toll Road Project in Monroe County will provide greater system reliability and operational flexibility in Southeast Michigan. The project is being conducted in three phases. Phase I involved construction of the new 120-kV Toll Road Station, which includes 11 120-kV breakers and reconfiguration of the Fermi-Swan Creek circuit into the station. This phase of the project was completed in April 2018.

Phase II of the project involves the installation of a new 150 mega volt ampere reactive (MVAR) SVC at Toll Road Station. SVCs provide an operational tool to ensure voltage stability for a diverse set of system conditions. This phase of the project was completed at the end of 2018. The Fermi-Vital 120-kV line will be cut into the station in early 2019 once the SVC installation is complete.

### PROJECT HIGHLIGHTS

- SVC technology provides voltage stability for a diverse set of system conditions.
- Provides greater system reliability and operation flexibility to southeast Michigan.
- Mitigates low-voltage constraints in anticipation of generation retirements in Michigan.

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Phase III of the project involves the completion of a fiber optic relay line between the Toll Road and Shoal stations. Once this project is completed, the Shoal line will be cut into Toll Road Station. This is expected to take place by the end of 2020.

#### **ABOUT ITC**

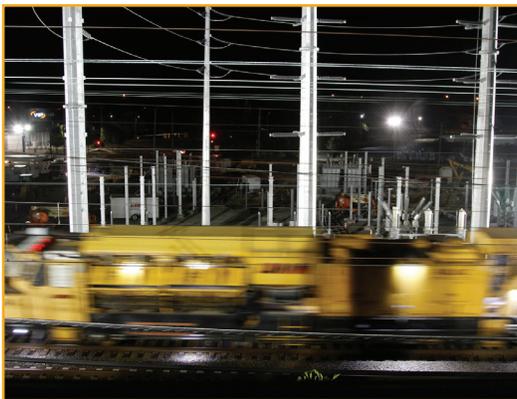
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Through its regulated operating subsidiaries, ITC owns and operates high-voltage transmission infrastructure in Michigan, Iowa, Minnesota, Illinois, Missouri, Kansas, and Oklahoma, and in development in Wisconsin. These systems serve a combined peak load exceeding 26,000 MW along approximately 15,800 circuit miles of transmission line, supported by 660 employees and nearly 1,000 contractors across an expanding footprint.

Additional information can be accessed at [www.itc-holdings.com](http://www.itc-holdings.com). ITC is a subsidiary of Fortis Inc.



## Bridgeport – New Haven Line Railroad Corridor - Transmission Line Upgrades



UI is progressing with upgrades to a number of critical 115-kV transmission lines located along the 16-mile, densely populated Metro North railroad corridor between Bridgeport and New Haven, Connecticut. This transmission corridor provides significant support to the heavily loaded southwest Connecticut area. The

needs driving these upgrades range from clearance concerns (resulting from NERC FAC-008), capacity shortfalls, and a need for general repair and replacement of some equipment.

Upgrades along this busy commuter rail corridor include significant design and construction challenges associated with narrow urban rights-of-way, complex construction sequencing, and coordination with numerous property owners. The original construction along the existing railroad corridor includes transmission support structures attached to underlying railroad catenary structures, a pioneering railroad architecture at the time of construction, many of which are more than 100 years old. This upgrade includes the replacement of existing structures with new monopole towers adjacent to the existing railroad corridor. Dealing with these complex engineering and rights-of-way issues requires significant problem solving, both in the field and in the planning stages, as well as sustained and informed community engagement and outreach.

### PROJECT HIGHLIGHTS

- Transmission system upgrades along a busy and densely populated rail corridor to improve reliability and capacity concerns.
- Geographically and legally complex terrain meant that planners and field workers faced significant challenges.
- The project will deliver significant reliability benefits to the entire regional transmission system.

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These railroad corridor upgrades will provide significant reliability benefits to the New England Bulk Electric System by addressing known infrastructure asset issues and ensuring compliance with NERC, the Northeast Power Coordinating Council, and ISO New England regional reliability standards. The project is part of UI's Ten-Year Plan Ahead—an ambitious effort to invest in the company's electric system to meet tomorrow's demands. The Plan Ahead will ensure electricity continues to be as safe and reliable years from now as it is today. This system-wide upgrade to UI's transmission and distribution equipment is vital, as it addresses the increasing demand

placed on the company's ability to meet customer needs. Components of The Plan Ahead include the upgrading and replacing of legacy electric infrastructure, such as transformers and underground cable, and the building of new substations and transmission lines as necessary to increase the capacity of the system to meet customers' increased demand for electricity.

#### ABOUT UI

United Illuminating (UI) is a subsidiary of AVANGRID, Inc. (NYSE: AGR). Established in 1899, UI is engaged in the purchase, transmission, distribution, and sale of electricity and related services to approximately 333,000 residential, commercial, and industrial customers in the greater New Haven and Bridgeport areas of Connecticut. UI's service territory includes 17 Connecticut towns and cities in an area totaling 335 square miles along or near the southeastern shoreline of Long Island Sound. UI owns approximately 132 miles of electric transmission lines, 3,500 miles of electric distribution lines, and 32 substations. For more information, visit [www.uinet.com](http://www.uinet.com).

UI's parent company, AVANGRID, Inc. (NYSE: AGR), a diversified energy company with more than \$31 billion in assets, has committed to investing \$9 billion in its U.S. Networks and Renewables businesses from 2017 through 2020.



## Rapid Recovery Transformer (RRT)



The rapid adoption and integration of smarter, connected devices has transformed society and the economy drastically, and the energy grid along with it. Grid security is critical to national security, and electric companies are faced increasingly not only with delivering reliable service, but also anticipating and addressing

potential threats to the nation's critical power supply.

When high-voltage transformers fail unexpectedly, this can weaken the entire transmission system, potentially for long periods. Back-up transformers can be difficult to locate, take weeks to deliver, months to deploy, and a year or longer to replace. Only the nation's largest electric companies can maintain a fleet of unique spares on an economically viable basis. For most companies, locating, acquiring, and moving a large back-up transformer are costly and time consuming. While companies are locating, securing, and operating backup transformers, the transmission system remains in a less robust state, creating the potential for reliability issues.

Westar's new Rapid Response Transformer (RRT) is a part of the company's efforts to remain ahead of emerging security challenges and resilience requirements. Acting in the spirit of the 2015 Fixing America's Surface Transportation Act—but prior to it being enacted—Westar took the initiative to develop an innovative solution to the challenges inherent in securing and deploying critical infrastructure on an emergency basis. In rising to this challenge, Westar's engineers conceptualized and designed a rapid-recovery solution that would be faster and vastly more flexible than prevailing emergency infrastructure protocols. The result was a groundbreaking concept for a flexible, multi-tap, high-voltage transformer that could be optimally located, easily transported, and rapidly deployed to any of its key substations; a "Swiss Army knife" of high-voltage transformers.

### PROJECT HIGHLIGHTS

- Westar engineers designed the world's first mobile response transformer, the Rapid Recovery Transformer (RRT).
- The RRT greatly reduces the time to deploy a replacement from 30-60 days to plan, permit, and complete delivery, to 7-10 days.
- It provides 80 percent coverage of critical transformers on the company's transmission system, returning the grid to normal operation within days instead of weeks or months.
- One unit can replace up to 80 percent of Westar Energy's high-voltage transformers; equivalent to 5 uniquely configured typical spares.
- The RRT can be transported on regular semi-trucks, which eliminates the use of railroad and special heavy-duty hauling trucks.

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When first tasked with delivering a solution to the transformer replacement challenge, Westar engineers with years of experience and first-hand knowledge of the company's infrastructure were encouraged to think "outside the box." The result was a requirements-driven developmental approach that demanded a system capable of replacing large segments of the company's high-voltage energy grid,

and to do so within days, not weeks. Weight and dimensions had to be optimized for easy deployment. To be a robust solution, it would need to include flexible components and, most important, multi-tap voltage options adaptable to virtually any high-voltage substation on the company's system.

In 2014, Westar engineers began work on the first-ever, multi-high-voltage mobile transformer with plug-in cables and 345-kV bushings. The team successfully completed factory testing in January 2016, introducing a one-size-fits-all spare transformer boasting a number of innovative features including, multiple low- and high-voltage side taps to maximize flexibility; modular accessories; a modular, pre-installed cooling system; quick disconnect control cables using a common control cabinet; and optimally located, secure, F-5 tornado-rated permanent storage. The final product, delivered in May 2016, has had a tremendous impact not only for Westar, but also the entire North American energy grid. The RRT was an EEI Edison Award finalist.

While increasing its overall reliability with the adjustable voltage mobile transformer, Westar also seized the opportunity to build upon its recovery planning and ensure its critical backup was proof against all types of threats—from weather to weapons. The mobile transformer is a significant improvement in resilience and includes security features that protect it—and the energy grid—from damage or failure. These security features include the ability to react quickly to unforeseen events; bullet-resistant bushings; the ability to operate when filled with ester, rather than mineral oil, improve fire and environmental safety; and it is housed in a highly secure facility.

Delivered in spring 2016, it didn't take long for the deployment of the RRT to be realized. In late spring 2017, a large high-voltage transformer failed in the Topeka, Kansas area, which was projected to cause reliability issues in the area during the hot summer months. The RRT successfully was deployed prior to the onset of any reliability issues, helping to offset the need to run older generating units and improving operational flexibility in the area to support customer reliability.

## ABOUT WESTAR

In June 2018, Westar Energy (Westar) merged with Kansas City Power & Light (KCP&L) to form Eversource Energy. Eversource is an investor-owned, vertically integrated electric company serving approximately 1,600,000 retail customers in Kansas and Missouri. Westar and KCP&L will continue to operate under those brand names until they are rebranded as Eversource in 2019.

Westar has served Kansas for more than 100 years and is the state's largest electric company, with about 7,200 MW of electric generation capacity and approximately 6,400 circuit miles of transmission line.

As a key member of the Southwest Power Pool, Westar operates 6,400 miles of transmission lines and coordinates delivery of one of the continent's largest concentrations of renewable energy from rural areas of Kansas through its large substations and into load centers. Westar relies on high-voltage transformers to move power and maintain reliability across its vast and asymmetrical grid.





The **Edison Electric Institute** (EEI) is the association that represents all U.S. investor-owned electric companies. Our members provide electricity for about 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.

For more information, visit our Web site at **[www.eei.org](http://www.eei.org)**.