Guidehouse

Energy, Sustainability, and Infrastructure

The Value and Benefits of AEP Transmission Investments

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About Guidehouse

Guidehouse is a leading global provider of consulting services to the public and commercial markets with broad capabilities in management, technology, and risk consulting. We help clients address their toughest challenges and navigate significant regulatory pressures with a focus on transformational change, business resiliency, and technology-driven innovation. Across a range of advisory, consulting, outsourcing, and digital services, we create scalable, innovative solutions that prepare our clients for future growth and success. The company has more than 10,000 professionals in over 50 locations globally. Guidehouse is a Veritas Capital portfolio company, led by seasoned professionals with proven and diverse expertise in traditional and emerging technologies, markets, and agenda-setting issues driving economies around the world.

The electric transmission grid in North America is considered the largest machine in the world. Modern society depends on a reliable grid as an essential resource for national security, health, and welfare. It is at the heart of our systems for communications, finance, transportation, food, and water supply. In short, we all expect and require electricity at the flip of a switch. Today, the transmission system encounters a brand-new set of challenges. The system is used in new ways as legacy generation is retired and replaced with renewable resources. It faces new threats from physical and cyber attacks and from more severe weather events. Providing a reliable and resilient transmission grid is more important and challenging than ever. The Edison Electric Institute (EEI) estimates that 30% of the US transmission system is at or near the end of its useful life. Furthermore, it is an unacceptable practice for this industry to run grid components to failure when the high energy they contain can lead to catastrophic results if improperly discharged.

American Electric Power's (AEP's) system serves more than 5 million customers and covers 11 eastern and central states in the US, representing 10% of the demand in the power grid's Eastern Interconnection. AEP is the largest builder, owner, and operator of transmission in North America. It has more than 40,000 miles of high voltage network assets provide the backbone to maintain regional and local reliability, efficient markets, financial stability, and economic growth. AEP customers have enjoyed more than a century of service, which also reflects the time period over which AEP has been building and maintaining its transmission system. The existing transmission system was built to last, and it has lasted. However, parts eventually wear out or become obsolete. Even with responsible maintenance, power lines and other equipment eventually require replacement.

While much of AEP's transmission system is state-of-the-art and includes the nation's only high capacity 765 kilovolt (kV) system, more than 11,000 miles of the company's transmission network will be over 70 years old within the next 10 years. Notably, approximately 1,500 miles of AEP's 138 kV transmission backbone in its eastern territory was built in or before the 1930s. The current condition of the 1930s-era transmission backbone and other aging equipment does not meet today's design guidelines or operational and safety standards. This 1930s-era transmission backbone features primarily 138 kV lattice towers, conductors, and poles, many of which have provided service beyond their expected life; and even with ongoing maintenance, can develop material and structural vulnerabilities if not replaced in a timely fashion.

Proving the Value and Benefits of Transmission Investments in Building the Grid of Tomorrow

Guidehouse recently completed a study related to the value and benefits of AEP's transmission investments. Two case studies analyzed the potential cost impacts – in dollars and in number of outages – had the company not taken the proactive steps to plan for necessary system improvements. The study revealed significant benefits to public safety, electric service reliability and resiliency, economic and environmental impacts, and efficient market operations, as shown in Figure 1.

Safety: AEP's top priority is safety for customers, employees, and the public. The high voltage power grid is inherently dangerous. Repair and/or replacement of deteriorating and aging infrastructure is the highest priority and mitigates the potential for toppled structures, downed wires, and other failures. Although AEP actively maintains its grid, there comes a time when replacement is more appropriate than rehabilitation based on condition, performance, risk, and consequences of failure. As equipment approaches the end of its useful life, it can become less sound. Tower structures become weaker, parts deteriorate, equipment tolerances decline, and lines have a higher risk of frequent and prolonged outages due to failure. These risks can also lead to safety considerations for workers and the public when equipment fails and power is out.

Figure 1: Example Benefits of Transmission Investments

(Source: Guidehouse)

Reliability and Resilience: Greater reliability and resilience are achieved by adding stronger equipment and new technologies to protect the system against damaging weather conditions and physical and cyber attacks. The consequences of not acting are concerning and make a compelling case for continuing diligence. Outages result in lost economic activity, crippled communication devices and networks, and potential safety issues. While historically much of the resilience discussion has centered around abnormal natural weather conditions, disruptive space events, and man-made threats, this year brings a new concern. As the coronavirus pandemic continues to grip the world, it has become clear that hardening the grid to withstand the more extreme weather events will potentially lessen the chance of outages occurring during an unplanned pandemic. Reducing the outage risk lessens the need to put line mechanics and other workers in harm's way and reduces the risk of catching COVID-19 while performing outage restoration. This also assumes that workers are healthy, available, and not in quarantine during such an outage event. Weather will not wait for a pandemic to subside, and man-made threats may even attempt to synchronize with such an event. Of further concern is the assured supply of high voltage equipment with long lead times, most of which is manufactured abroad. With borders closed, continued access to steady supplies is called into question.[1]

Sustainability: As the power grid incorporates the plan to integrate distributed energy resources such as solar, wind, energy storage, and electric vehicles into the grid, power transmission becomes vital and serves as the market enabler to integrate these resources. Improved grid intelligence, including situational awareness and automated controls, enables planners and operators to harmonize these resources and assets into the power grid. As the energy generation and supply portfolio shifts to new types of resources, such as renewable energy resources, the transmission system provides the enabling technology to harmonize these resources into the existing portfolio and the broader market. Tomorrow's transmission grid must also be ready for more electrification from new technologies like EVs and battery storage. Grid modernization technologies, including intelligent technologies or the smart grid, provide situational awareness, local coordinated control, and other features essential to integrating these technologies. The integration of distributed resources, variable renewable resources, and new storage technologies relies on a robust transmission grid to keep pace.

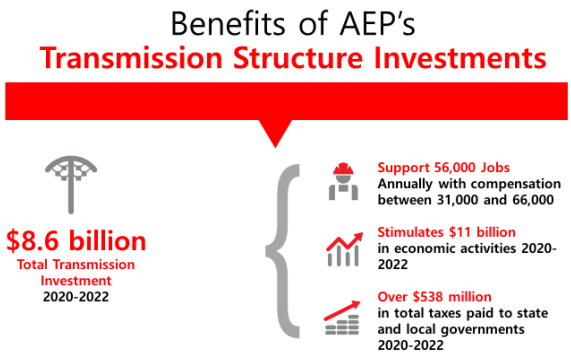
Economic Benefits: A strong, stable, and intelligent grid helps to avoid severe financial impacts to customers that rely on a continuous supply of power to run their businesses and households. The study Guidehouse performed for AEP also analyzed the broader economic benefits of transmission enhancements and expansions, including the creation of jobs, economic activities, and tax revenue. The study analyzed the economic impact of AEP's current and planned future investments for the years 2020-2022 and breaks down the value by state, including identifying the direct, indirect, and induced benefits.

[1] AEP and others have been proactive by establishing Grid Assurance, which provides effective spare equipment storage and sharing among utilities.

Proving the Value and Benefits of Transmission Investments in Building the Grid of Tomorrow

The present and future overall capital investments across the AEP service territory support an estimated 19,600 jobs and provides a benefit of $3.85 billion for every $1 billion per year invested during the 2020 to 2022 timeframe for construction of transmission projects – workers are employed, local communities benefit, and goods and services are purchased. The direct dollars for the projects are multiplied further and travel farther due to the indirect and induced effects as primary suppliers themselves rely upon secondary suppliers and households spend their income back into local businesses. Projected state and local taxes offer additional value with a total of $610 million in tax dollars for every $1 billion of capital investment providing revenue for state and local governments across the AEP territory, as shown in Figure 2. Property taxes are a large factor in generated revenue due to the accumulating value of AEP assets, with estimated annual property taxes of $489 million for every $1 billion dollars invested between 2020-2022.

Figure 2: Economic Benefits of AEP's Investments



(Source: Guidehouse analysis of AEP data)

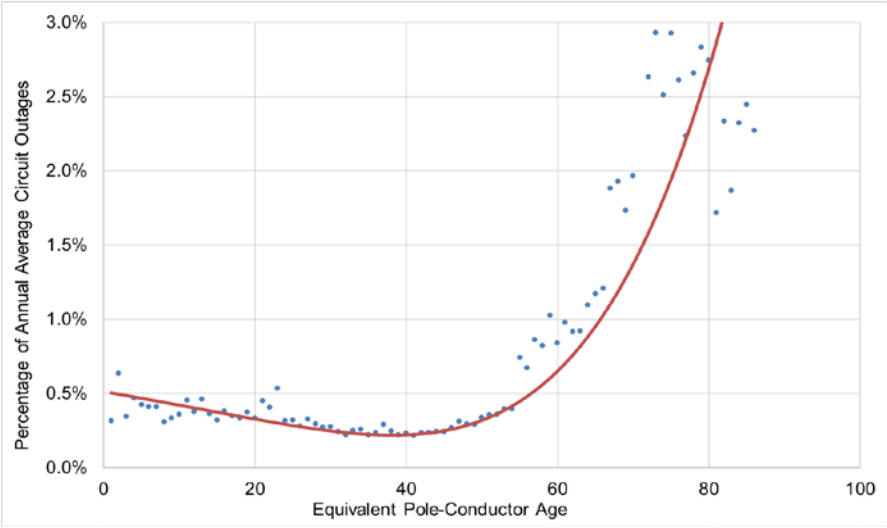
The Value Proposition

The true economic costs of outages are startling at a macro-level and can be devastating on a personal level. A study by the Lawrence Berkeley National Laboratory put the estimated annual cost of US sustained power outages (those lasting more than 5 minutes) from all sources at $44 billion.[2] The grid keeps us productive and connected through working communications networks, a vital commerce network, and personal and business electronics. The AEP study analyzes the impacts of the planned replacement of aging infrastructure being delayed. Two predictive models assess the following:

- Impact of aging poles (wooden and steel) and conductors on transmission system outages
- Impact of aging lattice towers and conductors on transmission system outages

Figure 3 shows a sharp increase in circuit outages after the transmission system infrastructure reaches 50-60 years of age. Figure 3 also shows the relationship between the equivalent pole-conductor age and normalized average annual outages. The percentage of average annual outages show the number of assets of the given age or vintage that are expected to have an outage. In other words, each data point indicates the rate of failure experienced by customers. For example, in the figure below, of the assets that are approximately 65 years old, approximately 1% are predicted to fail each year.

Figure 3: Impact of Aging Poles-Conductors on Transmission System Outages



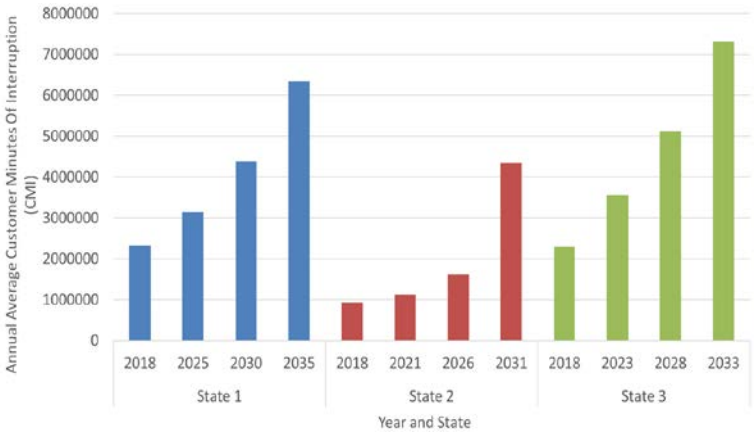
(Source: Guidehouse analysis of AEP data)

[2] https://emp.lbl.gov/news/berkeley-lab-estimates-sustained-electric

The Value Proposition

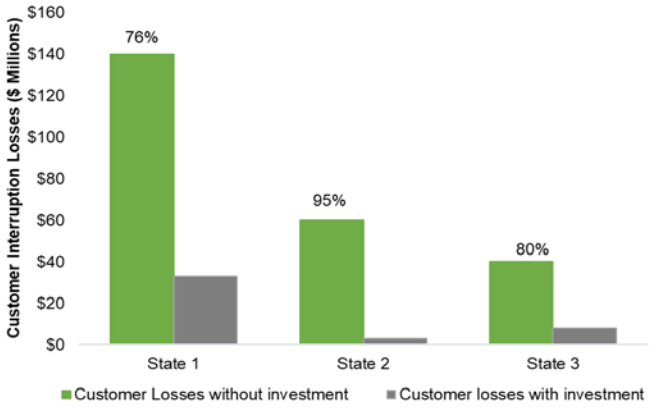
For a 40-year-old asset, the failure rate is approximately 0.25%. However, as the age increases, the failure rate increases exponentially, climbing to approximately 2% for 75-year-old assets. Therefore, the risk of failure at 75 years of age is predicted to be around 8 times greater than the risk of failure at age 40. A case study based on Figure 3 predictive modeling was conducted by selecting a sample of worst-performing circuits. The results from this analysis are as shown in Figure 4. This shows that annual average Customer Minutes of Interruption (CMI) can potentially increase by three times over a period of 10 years without investment.

Figure 4: Progression of Estimated Increase in CMI by Circuit



(Source: Guidehouse)
Illustrative example only – does not reflect actuals.

Figure 5: Comparison of Customer Interruption Cost Estimate of Losses with and without Aging Infrastructure Upgrades



(Source: Guidehouse)
Illustrative example only – does not reflect actuals.

An industry standard to measure the monetary impact of power outages is the Value of Lost Load (VOLL), which represents customers' willingness to pay for uninterrupted electricity service. This is measured as $/kilowatt-hours (kWh) or $/megawatt-hours (MWh). This method quantifies the impact to different customer classes when they lose electric service for several minutes during the year; it does not represent the value of the revenue for the utility. Figure 5 shows the comparison between the customer losses incurred due to interruptions with and without aging infrastructure upgrade investments by operating company. As quantified from the VOLL analysis, the percentage of customer interruption costs ranges between 76% and 95% as a result of the recent or planned investment.

Conclusion

A safe, secure, agile, and adaptable transmission grid requires proactive planning and modernized equipment. This study illustrates the quantitative and qualitative values and benefits of AEP's transmission investment. It highlights the jobs and associated economic development supported during infrastructure construction. It details the level of ongoing property tax benefits paid to local communities where critical system facilities are located. The predictive modeling describes the potential economic impact of losing electric service by looking at both outage minutes and the dollar costs to customers during those times when the lights go out, stores close, and factories come to a standstill. The modeling calculations also provide insight to the risk that delaying the replacement of poorly performing and/or aging equipment can pose to grid reliability.

Investing now in a strong and modern transmission grid will save money in the long term, while enabling a more diverse and cleaner electricity mix, reliable electricity supply, and deployment of new advanced power sector technologies. In summation, it is well-documented by various government and third-party sources that transmission investments are key to the country's future. The National Business Roundtable describes the grid's value in this way: "Like other forms of infrastructure, America's energy infrastructure is a key driver of job creation, growth and competitiveness throughout the economy. Maintaining a modern, flexible and secure network of electric power transmission is essential to delivering affordable and reliable energy to US businesses and consumers, promoting growth across all sectors of the economy, and supporting the country's thriving domestic energy industry."[3]

[3] https://www.businessroundtable.org/electricity-infrastructure