Looking Towards the Future:
Advantages of 765-kV Transmission Technology

In the electric transmission business, design plays a key role in the efficiency and productivity of the nation’s energy delivery system.

Electric Transmission America, LLC (ETA) believes that high-voltage, high-efficiency transmission facilities are the cornerstone of efforts to maximize system performance while minimizing overall environmental impacts and system cost.

ETA’s partners, American Electric Power (AEP) and MidAmerican Energy Holdings Company, are advancing the concept that high efficiency transmission systems should serve as the foundation for new transmission investment that will become the electrical equivalent of the national interstate highway system. By easing the loads on tired and often overtaxed transmission systems, ETA is looking to raise the bar on transmission design and system performance. In particular, ETA believes that 765-kilovolt (kV), extra-high voltage transmission offers a number of appealing technological and operational advantages for expansion of the nation’s energy grid.

Resource Conservation

- A single-circuit 765-kV line can carry as much power as three single-circuit 500-kV lines, three double-circuit 345-kV lines, or six single-circuit 345-kV lines, reducing the overall number of lines and rights of way required to deliver equivalent capacity.
- The high capacity of 765-kV can easily facilitate the efficient and economical integration of large-scale renewable generation projects into the nation’s transmission grid.
- ETA projects use a minimum right-of-way width of 200 feet for 765-kV construction. Standard industry right-of-way width for 500-kV is also 200 feet, and 150 feet for 345-kV construction. For equivalent power carrying capability, lower voltages require more lines and as a result more right-of-way.
- Typical 765-kV lines have a tower height of approximately 130-140 feet. This is 30-40 feet shorter than a typical double-circuit 345-kV tower.

Performance and Design Efficiency

- Power losses in a transmission line decrease as voltage increases. Since 765-kV lines use the highest voltage available in the United States, they experience the least amount of line loss.
- The greater transmission efficiency of 765-kV can be attributed mainly to its higher operating voltage (and thus lower current flow) and larger thermal capacity/low resistance compared to lower
Electric Transmission America, LLC
Working Locally for Regional and National Solutions

The blended competencies of the Electric Transmission America, LLC (ETA) partners -- American Electric Power (AEP) and MidAmerican Energy Holdings Company (MEHC) -- combine to produce a level of transmission leadership and expertise unmatched by other companies.

**MidAmerican Energy Holdings Company**
MEHC, based in Des Moines, Iowa, is a global leader in the production, transportation and delivery of energy from a variety of fuel sources – including coal, natural gas, geothermal, hydroelectric, nuclear, wind and biomass. MidAmerican offers a commitment to long-term investment in the utility sector, and currently is the fifth largest electric transmission owner in the United States.

Through its energy-related business platforms – PacifiCorp, MidAmerican Energy Company, CE Electric UK, Kern River Gas Transmission Company, Northern Natural Gas Company and CalEnergy – MidAmerican provides electric and natural gas service to more than 6.9 million customers worldwide. MidAmerican subsidiaries PacifiCorp and MidAmerican Energy Company own and operate more than 18,000 miles of electric transmission lines.

**American Electric Power**
AEP, headquartered in Columbus, Ohio, is one of the largest electric utilities in the United States, delivering electricity to more than 5 million customers in 11 states. AEP ranks among the nation’s largest generators of electricity, owning nearly 38,000 megawatts of generating capacity in the U.S. AEP also owns the nation’s largest electricity transmission system, a nearly 39,000-mile network that includes more 765-kilovolt extra-high voltage transmission lines than all other U.S. transmission systems combined.

AEP is a leader in the development of transmission technology, and has been since the earliest days of its history. AEP energized the first long-distance transmission line connecting a mine-mouth power plant with a major load center in 1917. In 1969, AEP was the first company in the world to introduce 765-kilovolt (kV) transmission technology, the highest voltage used in the United States today.

**ETA’s Commitment to Working Locally**
ETA is committed to working with local partners to ensure that the interests of local and regional stakeholders are reflected in our projects.

**Prairie Wind Transmission, LLC** -- ETA is working with Westar Energy Inc., the largest utility in the state, to pave the way for an expansion of renewable generation in Kansas and within the Southwest Power Pool (SPP). Prairie Wind Transmission is poised to build some 230 miles of extra-high voltage 765-kilovolt (kV) transmission facilities that will provide enhanced electricity transport in Kansas create new jobs and economic development opportunities for local communities and enable renewable energy to be delivered to electric customers throughout Kansas and the region.

**Tallgrass Transmission, LLC** – ETA is working with OGE Energy Corp., to build approximately 170 miles of extra-high voltage 765-kilovolt transmission from the Kansas-Oklahoma border north of Woodward, Okla., which will link into OGE’s station at Woodward and then extend west into the Oklahoma panhandle to a new station that will be built near Guymon, Okla.

ETA, in partnership with these two local utilities, has the experience, ability and financial resources to work effectively with all stakeholders toward the successful completion of this important undertaking.
voltage lines. This also allows 765-kV lines to carry power over significantly longer distances than lower voltages.

- With up to six conductors per phase, 765-kV lines are virtually free of thermal overload risk, even under severe operating conditions.
- By shifting bulk power transfers from the underlying lower-voltage transmission system to the higher-capacity 765-kV system, overall system losses are reduced significantly.
- New 765-kV designs have line losses of less than one percent, compared to losses as high as 9 percent on some existing lines.
- The overlay of a 765-kV system allows for both scheduled and unscheduled outages of parallel lower voltage lines without risk of thermal overloads or increased congestion.

**Minimizing Costs**

- Use of 765-kV technology allows transmission builders to take advantage of economies of scale. A typical 765-kV line costs approximately $2.6 million/mile. For equivalent capacity, three 500-kV lines at a cost of $6.9 million/mile or six 345-kV lines at a cost of $9.0 million/mile would be required. In other words, 765-kV construction is only 29% of the cost of 345-kV and 38% of the cost of 500-kV for a comparable system.
- Utilizing 765-kV results in a substantial reduction in system losses. For instance, a loss reduction of 250 megawatts, equates to saving as much as 200,000 tons of coal, and 500,000 tons of CO₂ emissions on an annual basis.
- The addition of 765-kV systems relieves the stress on underlying, lower voltage transmission systems, postponing the potential need for upgrades of these networks. This results in additional savings for end-use customers over time.

Our electric intensive society relies on the reliable delivery of power. By designing bulk power transmission systems to maximize efficiency and operational functionality, ETA is working to ensure that we can meet the energy needs of the nation’s electricity users in a responsible and cost-effective manner.
Supporting Wind and Renewable Energy:  
**Critical to Energy Independence**

Extra-high voltage transmission is a class of transmission that provides unique benefits to the transmission system. When overlaid on top of an existing lower voltage transmission system, it serves to enhance the efficiency, operation and flexibility of the entire system. One of the biggest long-term barriers to the widespread use of wind energy to supplement our country’s growing demand for electricity is the physical limitations of the nation’s current electric transmission system. The nation's bulk transmission system is currently inadequate to deliver energy from remote wind resource areas to electrical load centers.

**Electric Transmission America, LLC (ETA)** believes that this barrier can be overcome by building efficient extra high-voltage (EHV) transmission infrastructure that will enable wind power to become a larger part of the nation’s power generation resource mix. This transmission system expansion will bring many additional benefits, including increased reliability and greater access to environmentally friendly sources of electricity.

ETA partner, American Electric Power (AEP), has long been a pioneer in the development and advancement of extra high voltage technology and in 1969 introduced 765-kilovolt (kV) transmission, the highest voltage used in the United States today. AEP owns more 765-kV extra-high voltage transmission lines than all other U.S. transmission systems combined. Based on AEP’s experience, ETA believes that:

- 765-kV technology provides an excellent platform for expanding the nation’s transmission infrastructure.
- EHV transmission expansion is key for the growth of large-scale renewable generation, which is critical for increasing our nation’s domestically fueled electricity supply and for reducing our country’s carbon emissions.
- The use of 765-kV AC technology will enable the development of a new high-capacity bulk transmission grid overlaying the existing lower voltage system, with both systems easily integrated where so required.
Expanding Access to Renewable Resources

The most viable renewable generation resources are not located close to population centers, so additional transmission is essential to move renewable power from where it can be created to where it can be consumed.

Inadequate transmission prevents fuel diversity for electricity generation. Fuel preferences vary regionally, based largely on what energy sources were locally abundant when regions were electrified. Without transmission to deliver electricity generated by diverse fuels, local areas remain at the mercy of fluctuating fuel prices. Additional EHV transmission will support additional long-range electricity transportation and reduce dependence on imported fuels, enhancing domestic energy security.

ETA believes that an expanded EHV transmission system provides the most efficient method of interconnecting remotely located wind, and other renewable generation resources with a system that is capable of delivering such resources to the areas that need them. Today's underdeveloped and heavily loaded transmission system is inadequate for this purpose, especially on the scale that is required to meet new renewable energy goals.

Taking the Lead

ETA already is working to unlock the potential of renewable energy through its Prairie Wind Transmission, LLC and Tallgrass Transmission, LLC projects in Kansas and Oklahoma, respectively.

- Prairie Wind Transmission, LLC is a joint venture of ETA and Westar Energy, Inc., that plans to build approximately 230 miles of extra-high voltage 765-kilovolt (kV) transmission facilities extending from Wichita, Kan., west to a substation northeast of Dodge City, Kan., and then south to the Kansas border from Medicine Lodge, Kan. The project will provide enhanced electricity transportation in Kansas and support expansion of renewable electricity generation in the region.

- Tallgrass Transmission, LLC is a joint venture of ETA and OGE Energy Corp., that plans to build approximately 170 miles of extra-high voltage 765-kilovolt transmission from the Kansas-Oklahoma border north of Woodward, Okla., that will link into OGE’s station at Woodward and then extend west into the Oklahoma panhandle to a new station that will be built near Guymon, Okla.
Building an Interstate Transmission: 765-kV Value Proposition

- Advanced six-conductor bundles for higher capacity, lower line losses and reduced noise
- Fiber-optic shield wires for better protection and control
- Wide-area monitoring, control, and remote diagnostics
- Independent-phase operation for improved line performance
- Line design and right-of-way usage for least environmental impact

765-kV maximizes land use thus providing more capacity in less right-of-way.