Moving the Wind

by: Kansas Electric Transmission Authority

The Kansas Electric Transmission Authority (KETA) is one of a handful of state-level organizations that have been created, primarily in the Great Plains and western states, to improve the electric transmission grid. KETA was founded in 2005 by enactment of HB 2263, the Kansas Electric Transmission Authority Act. The Authority's mission is to ensure reliable operation of the electrical transmission system, diversify and expand the Kansas economy and facilitate consumption of Kansas energy through improvements in the state's electric transmission infrastructure.

KETA is authorized to fulfill its mission by building electric transmission facilities and by facilitating the development and improvement of third-party transmission facilities. The Authority cannot directly operate or maintain transmission facilities, but must contract for those services. Any transmission line costs incurred by KETA will be recovered through tariffs of the Southwest Power Pool or by Kansas Corporation Commission assessments of Kansas utilities.

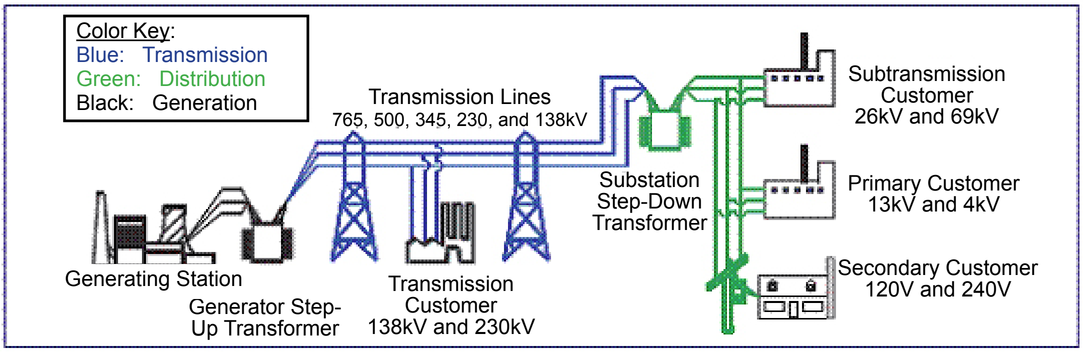
KETA is governed by a seven-member Board of Directors composed of four legislators and three gubernatorial appointees. Current Board members are Representative Carl Holmes, Chair; Earnie Lehman, Vice-Chair; Tim McKee, Secretary; Senator Pat Apple; Les Evans, Representative Annie Kuether, and Senator Janis Lee. The legislators are the chairpersons and ranking minority members of the House and Senate Utilities committees. Mr. Lehman is the President and General Manager of Midwest Energy, Inc., headquartered in Hays. Mr. McKee is a Wichita attorney and former Chairperson of the Kansas Corporation Commission. Mr.

Evans is Vice President of Power Supply for the Kansas Electric Power Cooperative.

In the three-and-one-half years since its founding, KETA has served as a focal point for discussion of transmission planning among electric utilities, independent transmission companies, renewable energy developers, and regulators. KETA studied and determined the need for a new transmission line from Spearville, located a few miles northeast of Dodge City, to Axtell, Nebraska. ITC Great Plains, the first transmission-only utility authorized to operate in Kansas, will build the Kansas portion of the line in two phases. The Nebraska Public Power District will construct the line north of the Kansas boundary. In addition, KETA has monitored Westar Energy's progress to improve transmission capability in the central portion of the state. New Westar lines are being constructed from Wichita north to Salina and from Wichita south to the Oklahoma border. Most recently, KETA and a number of other interested parties intervened in a Kansas Corporation Commission docket to encourage expeditious construction of a high voltage transmission line from Wichita to Spearville.

This focus of KETA's activity on southwest and central Kansas is necessitated by the lack of high voltage transmission lines running across the state, the concentration of energy-intensive industries in the central part of the state, and by the growing demand for wind-generated electricity. Southwest Kansas is one of the nation's prime locations for generation of electricity from wind but also is an area lacking the infrastructure necessary to transmit electricity long distances to consumers. KETA will soon embark on an exploration of the best means to develop "collector transmission lines" to move electricity from wind farms to the high-voltage lines designed for long-distance transmission.

Figure 1



Source: North American Electric Reliability Corporation (NERC). "About NERC: Understanding the Grid." http://www.nerc.com/page.php?cid=1|15. Accessed May 13, 2009.

The Electric Grid

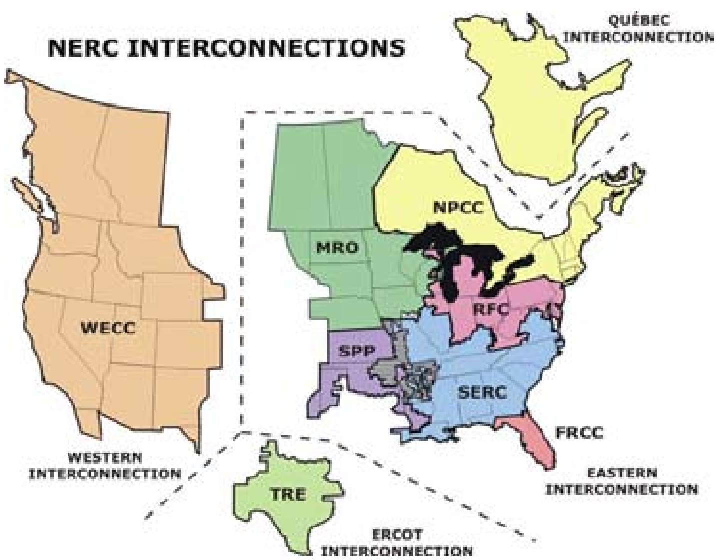
At its most basic, the transmission system (grid) is an interconnected assembly of power lines and associated equipment for moving electric energy at high voltages (typically 110 kV or above) between points of supply and points of delivery. Transmission lines typically operate at higher voltages than distribution lines in order to minimize the amount of energy lost during transmission.

Figure 1 illustrates how electricity travels from a source such as a power plant, or any other source of electricity such as a wind farm, to a transformer, where the voltage is "stepped up" for travel over long-distance transmission lines, and then "stepped down" at a substation for delivery over electric distribution lines to customers.

The North American transmission system today is an interconnected network composed of nearly 160,000 miles of high-voltage transmission lines. As Figure 2 shows, the transmission grid in the contiguous United States is divided into three separate, but connected, regions—the Western Interconnection, the Eastern Interconnection, and the ERCOT Interconnection. The east and west interconnections also include parts of Canada. Within each interconnection, electricity most commonly flows along alternating current (AC) transmission lines over paths of least resistance. In some places, electricity within an interconnection is transmitted over direct current (DC) lines in order to reduce line loss. These transmission lines tend to support high-voltage, point-to-point transmission over long distances.

The interconnections are linked in a limited number of places by DC transmission lines. Because of the separations between the eastern and western interconnections, for instance, a power disruption

Figure 2



Note that as of April 2009 most of Nebraska became part of the Southwest Power Pool (SPP)

Source: North American Electric Reliability Corporation (NERC). "Key Players: Regional Entities." http://www.nerc.com/fileUploads/File/AboutNERC/maps/NERC_Interconnections_color.jpg in Colorado could affect power flows as far away as California, but would not be likely to affect Kansas, which is part of the Eastern Interconnection. The extensive blackout in 2003 in the northeastern United States and parts of Canada is an example of the potential for far-reaching effects of a power disruption within an interconnection.

Figure 2, on the previous page, shows the transmission grid is a network on which power flows much like water flows through pipes, seeking the path of least resistance. Like water in a drainage basin, power is “fungible”—the power placed on grid by a power plant to fulfill a contract is not the same power the purchaser will receive. Coordinating the flow of power over the grid, and ensuring in real time that the amount of power generated and the amount used remain in balance, is a function carried out in the Eastern Interconnection by a number of regional organizations. As Figure 2 shows, Kansas is part of the Southwest Power Pool, or SPP, Regional Transmission Organization. The SPP was founded in 1941 with 11 members who pooled their resources to keep Arkansas aluminum plants powered for national defense work. The organization was maintained after World War II to support regional reliability and coordination.

The Southwest Power Pool covers a geographic area of 370,000 sq. miles and manages transmission in all or parts of 8 states, including Arkansas, Kansas, Louisiana, Missouri, Nebraska, New Mexico, Oklahoma, and Texas. The SPP is home to a major wind corridor, with the challenges and opportunities that resource presents. As officials noted, “The SPP region has huge wind potential, primarily in Kansas, Oklahoma, New Mexico, and the Texas panhandle. SPP has almost 3,000 MW of wind in service, with more than 55,000 MW proposed and under study. By comparison, [SPP’s] projected peak demand for 2009 is almost 50,000 MW.”[1] Kansas currently has approximately 1,000 MW of wind power generation capacity on line and more than 6,500 MW proposed for construction. To place the proposed amount in context, it is nearly equal to the total capacity of the Westar system. Certainly not all of the proposed wind projects will be developed. But adding even a portion of the proposed generating capacity will require construction of additional transmission lines.

New transmission lines are required because the physical properties of transmission lines limit the amount of power they can safely carry, demand for power is increasing in places far distant from wind production areas, and the current grid is nearly fully utilized. Adding large amounts of generating capacity in the Great Plains from wind or any other source requires new transmission lines to carry that power safely and reliably to customers and to avoid expensive congestion and bottlenecks.

Integrating Wind-Generated Electricity on the Grid

The best economic situation for wind-generated electricity is to have wind farms located in proximity to the long-distance transmission lines so that “collector transmission lines” that carry power from the wind farm to the interconnection can be as short as possible. The Southwest Power Pool analyzes interconnection requests to determine the necessary transmission system upgrades to service the requests. While that analysis is conducted on a case-by-case basis, some general characteristics of wind power impact the feasibility of moving the wind.

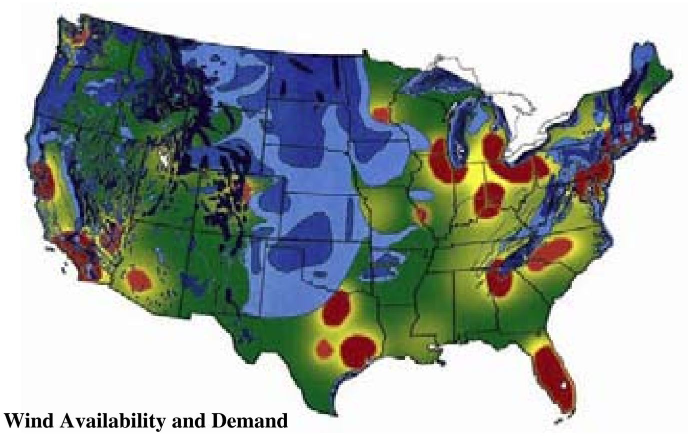
A number of challenges are presented when attempting to integrate wind-generated electricity onto the transmission grid. Most of those challenges are a result of characteristics of wind generation capacity: it is widely distributed; it is generally quite distant from customers; and it can be put in place relatively quickly—certainly more quickly than transmission lines can be built. In addition, wind generated electricity is intermittent. Unlike electricity generated from traditional fuels—natural gas, coal, or nuclear fuel—electricity generated by the wind is available only when the wind blows.

Distribution and Distance From Customers

Wind farms are located, by necessity, in the windiest parts of the country, which also happen to be areas where vast tracts of land tend to be available to house wind farms. As Figure 3 below illustrates, the largest areas of high wind potential in the United States are relatively distant from the nation’s high-demand areas.

Transmitting electricity long distances requires high-voltage transmission lines—345 kV and higher. Those lines are expensive, and siting them is sometimes difficult, especially near cities, environmentally sensitive areas, and in some agricultural areas. The Southwest Power Pool has observed that “new wind generation and transmission faces the same ‘not in my backyard’ issues as other types of generation. High-voltage transmission lines require significant rights-of-way, which are sometimes challenged by environmental organizations and property owners. There are concerns about how wind farms coexist with wildlife and agriculture.”[2] In Kansas the “best wind” is in the western portion of the state and in the Flint Hills. Most of the state’s population is located in the east. That would make the Flint Hills a prime location for wind farm development, but environmental concerns have prevented any significant development of wind generation in that area.

Figure 3



Wind Availability and Demand
Blue - high wind potential,
Brown - large demand centers, and
Green - little wind and smaller demand centers.

Source: North American Electric Reliability Corporation. *Special Report: Accommodating High Levels of Variable Generation*. April 2009

In addition to being relatively distant from customers in large population centers, wind generation facilities cover much larger areas than similar capacity using traditional fuels. Thus, more miles of transmission line are required to move the same amount of power as might be generated by a single, large conventional facility. As Figure 4 shows, the sizes and locations of Kansas' wind farms are widely distributed within the state. Wind-powered generation capacity currently installed or under construction totals slightly more than 1,000 MW in 8 different counties. By comparison, Westar's Jeffrey Energy Center, a coal-fired plant near St. Marys in Pottawatomie County, has nearly twice as much generation capacity in a single location.

The Southwest Power Pool is planning for transmission of wind-generated electricity within the SPP footprint and beyond. "To connect large volumes of new wind energy to the electric grid, more transmission must be constructed to carry the energy to where the demand is [sic]. SPP is studying how a 'transmission superhighway' of EHV [extra high voltage] lines would enable us to connect tens of thousands of renewable megawatts into the electric grid."[3]

Cost and a Game of Chicken

Another aspect of remote locations is the absence of existing transmission capacity. Traditionally, transmission lines have connected large generation facilities to distribution systems in cities served by those plants. In Western Kansas, where the wind blows most reliably, the sparse population has needed neither large generation facilities nor an extensive transmission system. The current focus on construction of new transmission capacity in the western portion of the state is driven in part by the desire to capitalize on the wind resources present there. According to the SPP, "the cost of building transmission from wind farms can be prohibitive. Wind power companies most often have to build in remote areas where there is little or no existing transmission infrastructure."[4] In order to alleviate some obstacles presented by the cost of building new transmission lines, the Southwest Power Pool recently implemented a cost-recovery method called the Balanced Portfolio, which will allow certain transmission costs to be allocated region-wide.[5]

Figure 4

Kansas Wind Farms

Name	Location	Power Capacity (MW)	Units	Year Online
Central Plains	Wichita County	99	33	2009
Flat Ridge I	Barber County	100	40	2009
Meridian Way	Cloud County	105	35	2008
Meridian Way II	Cloud County	96	32	2008
Smoky Hills II	Lincoln & Ellsworth Co.	148.5	99	2008
Smoky Hills Wind Farm	Lincoln & Ellsworth	100.8	56	2008

Table 1 adapted from American Wind Energy Association "U.S. Wind Energy Projects – Kansas" (As of 03/31/2009). http://www.awea.org/projects/Projects.aspx?s=Kansas. Accessed May 13, 2009.

Because building new transmission lines is so costly—$1 million to $4 million per mile—it often makes little sense for utilities to shoulder the cost of building them when most of the energy they carry will be delivered to customers of other utilities farther away. That is why the cost of new transmission lines that are being built to encourage wind development are cost effective only on a region-wide basis, that is, if the costs are shared by all who will benefit. The game of chicken that sometimes emerges in the planning process goes something like this. If a wind farm is built, but there is insufficient transmission capacity available on which to move the electricity to market, the wind farm developer cannot recover costs or earn a profit. If a new transmission line is built, anticipating development of new wind farms, existing customers must pay the additional construction and operating costs for capacity that they do not need. So, who blinks first, the wind farm developer or the builder of the transmission line?

Timing

As in any game of chicken, timing is everything. According to the Southwest Power Pool, "any new generation, fossil fuel or renewable, has to go through the generation-interconnection process to be added to the transmission grid. First, the generator completes an interconnection request. SPP then completes three studies: load flow (feasibility), impact (stability), and facility. Finally, a service-interconnection agreement is completed. This process can take more than a year."[6] When there is a backlog in scheduling transmission interconnection, there can be additional delays. When that time is added to the amount of time required by the company to plan the line, obtain the route and complete the regulatory process, it can be several years from identification of the need for a new line to it being energized. In some parts of the country, the time from the start of the regulatory process to energizing a new transmission line has been more than 10 years. Although Kansas has not experienced such long processes, the recently completed Wichita-to-Hutchinson 345 kV line was remarkable in that it went into service 2 years and 104 days from the time it was announced.[7] By contrast, a wind farm can be constructed in less than a year. Any delay of access to adequate transmission capacity adds cost to the electricity generated. Adding to the timing complexity is the fact that, unlike the situation that exists for traditional integrated generation and transmission companies, wind farms served by a single transmission line may be owned and operated by a variety of independent companies—none of which is necessarily owned or operated by the transmission owner.

Managing Wind on the Grid

Wind-generated electricity is characterized as an intermittent resource because the wind does not blow—and therefore, the electricity does not flow—all the time. The amount of wind-generated electricity averages 30% to 40% of capacity, so transmission lines moving the wind may be "underutilized" part of the time. Because management of the electric transmission system involves maintaining a balance of generation with demand (load), the on-again-off-again nature of wind-generated electricity adds to the complexity of load balancing. Some studies indicate that costs of integrating wind-generated electricity do not become significant until that source accounts for 15% to 30 % of the capacity.[8]

Efficiently balancing the input and output on the transmission grid impacts cost. Although any new power source faces transmission constraint issues, wind power is especially handicapped because of the typical long distance from demand centers and the potential under-utilization of expensive transmission facilities due to the variable output. Regulators like the Kansas Corporation Commission and the Southwest Power Pool consider the economic impact of decisions to expand transmission resources. That economic impact is ultimately felt in each home and business in the state.

All the Moving Parts

Harnessing and moving the electricity generated from Kansas' abundant wind resource is not a simple process of adding a pipe from west to east. A number of developers, utilities, planning and permitting entities, and all the state's ratepayers are involved. Each has a unique perspective and role to play in meeting the state's economic and energy needs.

About the Authors
The Kansas Electric Transmission Authority can be reached at keta@ink.org, or visit their website at http://www.kansas.gov/keta/ for more information.

1 Southwest Power Pool (SPP). "Wind Integration." http://www.spp.org/publications/SPP_Wind_Integration_QA.pdf. Accessed May 13, 2009.
2 Southwest Power Pool (SPP). "Wind Integration." http://www.spp.org/publications/SPP_Wind_Integration_QA.pdf. Accessed May 13, 2009.
3 Southwest Power Pool. *2008 SPP Strategic Plan*. December 12, 2008. p. 10. Little Rock, Arkansas.
4 SPP. Wind Integration.
5 *Id.*
6 *Id.*
7 Westar Energy. "Wichita to Reno County 345 kV Line Dedication." Slide presentation. January 12, 2009
8 Logan, Jeffrey and Stan Mark Kaplan. *Wind Power in the United States: Technology, Economic, and Policy Issues*. Congressional Research Service. June 20, 2008.

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