INTERSTATE TRANSMISSION SUPERHIGHWAYS: PAVING THE WAY TO A LOW-CARBON FUTURE[1]

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Imagine, for a moment, that today's Interstate superhighway system did not exist. Coast-to-coast delivery time for all sorts of goods we take for granted, from automobiles to asparagus, would take much longer and cost substantially more. Some goods might even be priced out of reach.

This situation, obviously undesirable, is similar to the problem plaguing the U.S. electricity transmission system, where the lack of a robust, integrated electric grid is rapidly emerging as the largest obstacle to the continued growth of the wind industry.

> Across the country, hundreds of wind projects comprising tens of thousands of wind turbines are on hold because no one wants to step forward and pay for upgrades that will primarily benefit others. The obvious solution to this problem is a policy framework that will allow firms interested in building new transmission to collect the costs of the infrastructure investment from those who will benefit from it.

In its recently released report "20 Percent Wind Energy by 2030,"[3] the U.S. Department of Energy (DOE) identified transmission limitations as a chief roadblock to realizing the enormous economic, environmental and energy security benefits of obtaining 20% of our electricity from the wind. Similarly, a poll conducted by NRG Systems[4] Inc. at last month's Windpower 2008 Conference in Houston, Texas, found that participants saw transmission issues as the biggest problem facing continued development of wind energy in the U.S.

The lack of electricity transmission infrastructure is particularly burdensome for wind energy development because wind resources tend to be located at a significant distance from population centers. The bulk of America's best wind resources are located in the plains, stretching south from the Dakotas to Texas, while most of the country's population lives along the coasts. Putting our country's incredible wind energy potential to use requires finding a way to move this electricity from where it would be generated to where it is needed.

Since almost all low-carbon electricity generation technologies are heavily dependent on developing new transmission infrastructure, significant investments in transmission are essential for the transition to a lower carbon future.

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[1] See http://www.renewableenergyworld.com/rea/news/story?id=53193.
[2] American Wind Energy Association (AWEA).
[3] See http://www.renewableenergyworld.com/rea/news/story?id=52471.
[4] See http://www.nrel.gov/wind/systemsintegration/news/2008/608.html.

A renewed investment in our outdated transmission system is a priority for other reasons as well. A stronger grid will be more reliable and more resilient in the face of potential disruptions caused by accidents or terrorist attacks. An investment in the grid will also reduce congestion — the grid's equivalent of traffic jams — that already costs consumers tens of billions of dollars per year in the form of higher electricity prices.

Of course, rethinking and ultimately reshaping the nation's electric grid is no small task. While the benefits of solving the country's transmission problems significantly outweigh the costs of the required investment, enacting the policies that will allow this investment to take place will require a hard-fought battle against entrenched political interests. To use an analogy that works both in terms of its scope as well as the political will that was necessary to get it done, solving our country's transmission problems will require the same type of forward thinking and bold leadership that made it possible to build the interstate highway system starting in the 1950s.

The Transmission Superhighway Vision

American Electric Power (AEP),[5] a major investor-owned utility with regulated power companies serving customers in eleven states, and AWEA have partnered to create a vision of what a nationwide transmission superhighway would look like. One potential transmission build-out scenario that would allow the U.S. to obtain 20% of its electricity from the wind would include 19,000 miles of new 765-kilovolt (kV) transmission lines, for an estimated price tag of US $60 billion. (A 765-kV line is a high-voltage power line that can carry larger amounts of electricity — and with significantly higher efficiency — than most older transmission lines in use today.) These high-voltage lines would serve as the backbone of an interstate transmission superhighway. A map of this scenario is provided in Figure 1, illustrating how new 765-kV transmission lines would be integrated with the existing high-voltage grid to interconnect new wind energy development in regions with significant wind resources.

[5] See http://www.aep.com/.

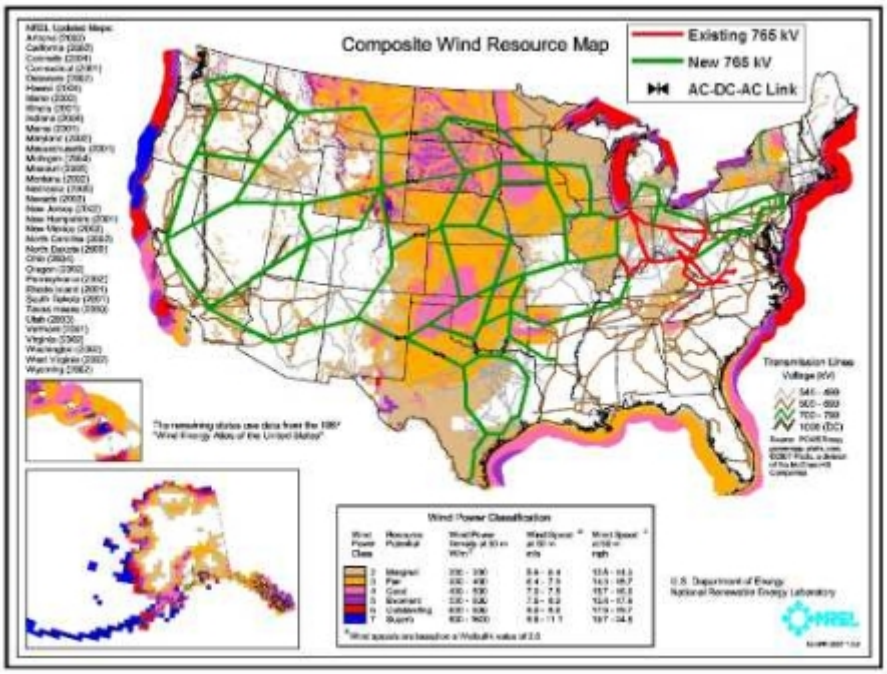

Figure 1: AEP-AWEA Transmission Superhighway Vision

While the size and cost of the transmission superhighway may sound large at first glance, it is important to keep these numbers in perspective. Given that electricity transmission infrastructure typically remains in service for 50 years or more, the cost of the investment for the average household would be equivalent to about US $0.35 per month, less than the cost of a postage stamp.

Those costs would be more than made up by the economic savings from replacing natural gas use with wind power generation, not to mention the benefits of reducing emissions of carbon dioxide (CO2) and other pollutants. In fact, the DOE report estimated that obtaining 20% of U.S. electricity from wind would reduce electricity sector natural gas use by 50%. In addition, the DOE study found that the 20% wind energy scenario would reduce CO2 by 7.6 billion tons between now and 2030. Electric sector CO_2 emissions would be reduced by 825 million tons in the year 2030 alone, an amount equal to 25% of all electric sector carbon dioxide emissions in that year or the equivalent of taking 140 million cars off the road.

A number of studies have found that the costs of transmission investments for wind power are significantly outweighed by the consumer savings that those investments produce. As illustrated in Figure 2, a 2006 study by the Electric Reliability Council of Texas (ERCOT) found that over time an investment in new transmission infrastructure would produce benefits many times larger than the cost of the investment.

Figure 2: Results of Texas Study on the Costs and Benefits of Transmission for Wind (Source: ERCOT)

In April of this year, ERCOT followed up with a more detailed analysis[6] of the costs and benefits of potential transmission expansion plans. The study found that the smallest transmission investment plan would bring enough new wind energy online to save US $1.2 billion per year in fuel costs — enough savings to cover the US $3.8 billion cost of the transmission infrastructure in a little over three years. The new wind brought online by the next largest transmission plan would save $1.7 billion per year in fuel costs, repaying the $4.9 billion cost of the investment in 2.9 years.

Similarly, the Midwest Independent System Operator (MISO) recently studied the costs of developing 16,000 megawatts (MW) of wind within its system (Midwest ISO, *Midwest ISO Transmission Expansion Plan 2006)*, along with 5,000 miles of new 765-kV transmission lines to deliver the wind from the Dakotas to the New York City area. Although the overall generation and transmission costs reached an estimated investment of US $13 billion, the project produced annual net savings of US $600 million over its costs. These savings are in the form of lower wholesale power costs and prices in the eastern U.S. resulting from greater access to lower cost generation in the western states such as Iowa and the Dakotas.

Multiple Benefits

Higher-voltage lines that would be built as part of a forward-looking transmission plan have a number of economic and environmental benefits over the lower-voltage lines that are built through the piecemeal, incremental transmission expansion practices employed in the past and still prevalent today. According to an April 2008 report by M. Heyeck and E. Wilcox entitled, “Interstate Electric Transmission: Enabler for Clean Energy,” a single 765-kV line can carry as much electricity as six 345-kV lines, using one-fourth as much land at one-third the cost and with one-tenth of the electricity losses. As a result, even though the 19,000 miles of new transmission lines envisioned in the AEP scenario would only amount to a 12% addition to the 160,000 miles of existing high-voltage transmission lines already in use in the U.S., they would be able to carry at least 20%-40% of U.S. peak electrical capacity.[7]

In addition to the benefits of integrating a large amount of new wind generation, a renewed investment in the country’s transmission infrastructure would also have significant economic and reliability benefits that would justify this investment even in the absence of wind. An ongoing study of new transmission options found that transmission congestion currently costs eastern U.S. consumers US $29 billion per year in the form of higher electricity costs. The preliminary results of the study

[6] See http://www.ercot.com/news/presentations/2008/ERCOT_Website_Posting.zip.
[7] See http://www.eei.org/industry_issues/energy_infrastructure/transmission/infrastructure2.pdf.

indicate that an investment in the transmission needed to significantly reduce this congestion would produce a net benefit for consumers of US $5 billion over the cost of the transmission. (Presented in D. Osborn, "Planning of a Power Transmission System Using Economic Tools," *JCSP Transmission Design Workshop*, June 2008) Similarly, Idaho National Laboratory recently released a study[8] concluding that five proposed transmission lines in the western U.S. would provide US $55-85 billion in annual benefits.

A Key to All Low-carbon Technologies

A growing chorus of experts has begun to express the concern that a lack of transmission infrastructure will present an obstacle for all low-carbon energy technologies, including renewable energy, nuclear power and coal power plants outfitted with carbon capture and sequestration technology. One of these voices is Kevin Kolevar, DOE's assistant secretary for electricity delivery and energy reliability, who explained in his written testimony at a Senate hearing[9] on June 17:

Significant new transmission will be necessary in the 21st century, largely because much of the Nation's future electricity demands will be met by generation sources located in areas that currently lack adequate grid connectivity. This applies to almost every type of generation:

- *Most of the nation's best wind and solar resources are located in remote areas where existing transmission capacity is either minimal or non-existent;*
- *Most new nuclear plants will not be sited in populous areas, and will likely require additional transmission capacity;*
- *Clean coal with Carbon Capture and Storage (CCS) will presumably be sited near geologic formations suitable for CO_2 storage, and may not be near major existing transmission facilities.*

Richard Sergel, president and CEO of the North American Electric Reliability Corporation (NERC), expressed similar concerns at an AWEA press conference on March 19:

We're sitting on the precipice of climate change legislation...It is in that context that we believe that the grid will be threatened unless we build the transmission infrastructure that is necessary to support renewable resources like wind, that will enable us to locate new clean coal facilities — or even the gas facilities — to locate them in places in which the grid will be able to withstand that so that we can meet the load requirements as they grow and have a reliable system for the operators to deal with."

Later, he added, "It doesn't matter if it's going to be the clean coal plant or the nuclear plant or the wind project or the solar project. The common denominator is that they are going to require transmission to move [electricity] from where it is [generated] toward the load centers."

Given that the process of planning, permitting and building transmission lines can take five to ten years or more, a failure to enact the policies to enable a major

[8] See http://www.pnwersenergyhorizon.com/files/PNWERReport_Rev2c_Final_16Jul08_ntwtm3.pdf.
[9] See http://energy.senate.gov/public/_files/KolevarTestimony061708.pdf.

investment in our transmission infrastructure will seriously limit our country's ability to address the climate change issue in a timely or cost-effective manner.

Forging A Path

Although a number of studies have made it clear that the multiple benefits of investing in new transmission drastically outweigh the costs, thus far policymakers have been slow to take action. Fortunately, however, awareness among policymakers is growing. The June 17 hearing at which Kolevar spoke, held by the U.S. Senate Energy and Natural Resources Committee "to examine the challenges and regional solutions to developing transmission for renewable electricity resources," was its first hearing ever on the topic. AWEA Transmission Committee Chairman and Board President-Elect Don Furman of Iberdrola Renewables[10] testified on behalf of AWEA at the hearing. The hearing was well attended, with four Republican and five Democratic Senators present and the hearing room full.

In his testimony, Furman asked Congress[11] to ensure that:

- *there are sufficient incentives to encourage investments in the transmission facilities necessary to fully develop our renewable resources;*
- *the costs of new transmission facilities are fairly allocated to take into account regional and national benefits, including the development of renewable electric generation;*
- *utilities are able to recover the costs of reasonable transmission investments;*
- *states cannot unfairly inhibit the development of transmission that will provide multi-state benefits;*
- *U.S. power marketing agencies, the Department of Energy, and [the Federal Energy Regulatory Commission] are encouraged to promote regional transmission infrastructure and system operations in support of renewable energy development; and*
- *legislation regulating greenhouse gas emissions recognizes the contributions transmission can make to reducing emissions in the electric generation sector.*

To use terminology from the field of economics, our inability to build new transmission is fundamentally a public goods problem. In most regions, policies require wind plant developers that want to connect to the electric grid to pay for the full cost of an upgrade to the grid network, even though the majority of the benefits of this upgrade would accrue to millions of electricity consumers and other power plants that could piggyback on this investment. Across the country, hundreds of wind projects comprising tens of thousands of wind turbines are on hold because no one wants to step forward and pay for upgrades that will primarily benefit others. The obvious solution to this problem is a policy framework that will allow firms interested in building new transmission to collect the costs of the infrastructure investment from those who will benefit from it. Reforming the patchwork of policies that currently govern the allocation of transmission costs and the siting of new transmission lines will require cooperation among local, state, regional, and national entities.

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[10] See http://www.iberdrolarenovables.es/wcren/corporativa/iberdrola?IDPAG=ENINICIORENOVAB.
[11] See http://energy.senate.gov/public/_files/FurmanTestimony061708.doc.

It is fitting that our response to issues of such immense chronological and geographic scope as climate change and energy security should be forward-looking and based on the larger national interest. A large-scale investment in a transmission superhighway is a critical first step in this direction. To do so, we must move beyond the narrow, short-term view that is frequently applied when assessing the costs and benefits of new transmission investments. In a similar display of leadership 150 years ago, a former railroad lawyer named Abraham Lincoln saw the important national interest in opening the American West to growth. He signed legislation to create the transcontinental railroad network in 1862, and seven years later a railroad system spanning the country was completed. Effectively addressing issues as large as the energy and climate change problems currently facing our country will require bold, forward-looking action of the type that our country has rallied to before in the face of adversity.

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This article first appeared in July 2008 Windletter, the monthly newsletter of the American Wind Energy Association,[12] *and was republished with permission.*

[12] See http://www.awea.org/.