

Vision for a 21st Century "Interstate Electric Highway System"

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Summary

- Electricity is fundamental to our quality of life.
- Changes in the nation's electrical system need to keep pace with our modern requirements. Among the critical changes that are needed are improvements to the transmission system.
- High-voltage transmission offers a wide range of well-known benefits.
- Given 21st century requirements for clean, reliable and affordable electricity supply in a carbon-constrained world, the nation's needs cannot be achieved without significant enhancements in our extra-high-voltage transmission system.
- Achieving the nation's requirements for clean, reliable and affordable electricity supplies requires a new vision for a 21st Century "Interstate Electric Highway System," built on a new national 765-kv transmission system overlay.

Electricity is fundamental to our quality of life.

- Most Americans don't think twice about their electricity supply and how it gets to them. They expect electricity to be available at the socket, whenever they need it, no matter how many appliances they plug in, at near-perfect levels of reliability, and at a reasonable cost.
- Today, Americans use 13 times the electricity they used a half century ago, when the American population was roughly half its current size.
- In all but one of the past 25 years, Americans increased their use of electricity over the amount used in the previous year. Electricity use continues to rise domestically (as it does internationally), and it does so faster than overall energy use.
- In some way, this is no surprise, given the price increases in other fuels:
 - Compared to 1990 when oil was just under \$25 per barrel, the price of oil is now nearly six times that level (at a high of over \$145.00 per barrel during the summer of 2008).
 - Since 1990, gasoline prices have nearly tripled and natural gas prices have risen nearly fourfold.
 - By contrast, over that same period, the average price of electricity rose by approximately 40 percent (from 1990 through 2005).
 - Some energy sources used to produce electricity offer even stronger fuel advantages: From 1990 to today, the price of fuel used to power wind turbines has remained the same – at zero cents per kilowatt-hour.

Changes in the nation's electrical system need to keep pace with our modern requirements.

- There are well-known challenges facing the American electric industry.
 - Our electric system must continue to provide the level of reliable supply that Americans take for granted and that our economy counts on.

- It must do so with new challenges in this century compared to the last:
 - An increasingly aging base of electrical infrastructure.
 - Growing demands for advanced technology better suited not only for a digital economy but also to customers' needs to better manage their use of electricity.
 - Global climate change, which will require significant reductions in greenhouse gas emissions from the power sector, as well as in other parts of the economy.
- Changes in all elements of the electric system need to be part of the solution to providing clean, reliable and affordable power:
 - Power production – investing in new, efficient, clean, advanced power generation technology;
 - End-use – making buildings, appliances, heating systems more efficient;
 - Power delivery – enhancing the ability of regions to support each other's power requirements for clean, reliable and affordable power.
- Transmission's role in solving these national challenges is too often overlooked as the focus shines on power plants and demand-side measures.
 - But inadequate attention to enhancing the nation's electric transmission system will undermine – if not prevent – our ability to satisfy our national economic goals while also addressing climate change and our needs for energy independence.

High voltage transmission offers a wide range of well-known benefits.

- The benefits of high-voltage transmission have been understood for decades:
 - Network reliability, allowing for
 - power production systems to assist one another as system conditions change over time;
 - the grid to remain flexible as conditions on the system change from moment to moment;
 - various regional systems to install less power plant capacity locally, because they share reserves through transmission interconnections.
 - Movement of electricity produced in one area to another, allowing for
 - power to be delivered to customers in homes, offices and factories located far away from the power plants that produce their power;
 - utilities and their customers access to lower-cost, diverse power supplies available at different times in different regions;
 - inter-regional trading to help drive down overall power production costs;
 - regions to reduce their vulnerability to extreme conditions and catastrophic events (including long-term power plant outages or extreme weather conditions causing high use of electricity);
 - regions with plentiful energy supplies to develop them for distant markets, gaining economic development, tax base, and jobs; and
 - movement of power from resource-rich basins (e.g., hydroelectric power, wind resource areas) to consumers in other regions.

Given 21st century requirements for clean, reliable and affordable supplies in a carbon-constrained world, significant enhancements can be provided by extra-high-voltage transmission (EHV).

- A robust EHV transmission system connecting regional electrical systems dramatically enhances the nation’s power system and the services it provides to electricity users.
 - It modernizes the system.
 - It strengthens electric reliability and clean power development by linking systems and regions.
 - It moves power efficiently, with lower line losses as power moves from one place to another, and with improved operational flexibility.
- *System modernization:* When done in parallel with other enhancements of the system, EHV is part of the 21st century electrical system.
 - These companion enhancements improve both the customer end of the system, the sources of power supply, and the links between the two.
 - These enhancements include:
 - aggressive development of demand-side measures and distributed generation to make our electricity use more efficient and resilient based on resources located physically close to customers. Active discussions are underway on how to implement what’s needed in a “national action plan for energy efficiency.”
 - investment in smart meters and other energy management systems to give customers greater control over their energy use. There are parallel, active discussions on how to advance such technologies.
 - investment in advanced power generation technology with low greenhouse gas emissions. Significant attention to this topic is being developed in policy, technology and investment circles.
 - EHV transmission, connecting regions rich in resources with customer markets. This element of the framework needs newly focused attention and a new vision for the nation’s transmission system, aimed more at interregional benefits and opportunities as compared to the historical focus on transmission as local infrastructure supported in local electricity rates.
- *Linking clean power development while enhancing both energy security and reliability:* An EHV overlay system would allow integration of systems of resources and markets – enabling regions that are rich in indigenous clean energy to develop economically and supply power to areas in need of cleaner power supplies.
 - While the last-decade’s discussions about the need to enhance inter-regional power markets focused on reaping benefits from greater competition (through power trading), this decade’s focus must shift toward how to tap our nation’s domestic energy supplies in ways that support energy security, economic development, and significant greenhouse-gas reduction:
 - In so many areas of the economy – agriculture, banking, tourism, ports, high-tech industries, and so forth – the regions of the country depend upon each other for producing goods and services for both local and distant American consumers.

- This is true in our energy markets generally, with energy supplies moving from one region to another, with
 - the Gulf States producing much of the nation's domestic oil and gas supplies;
 - oil refineries located in states as diverse as California, Illinois, Texas, New Jersey, and Pennsylvania, providing gasoline and other petroleum products;
 - the Rockies and Appalachian areas providing coal to supply half of the nation's electricity;
 - fields in the Midwest providing grain for ethanol;
 - rivers in the Pacific Northwest providing hydroelectric power for use by Western electricity consumers;
 - ports in Boston and near Baltimore providing access to global liquefied natural gas supplies for consumers in the Northeast;
 - wind resources in the Plains, Texas and other parts of the Southwest providing electricity to the local regions.
- No region of the country is self-sufficient today from an energy point of view, or in terms of providing for itself the array of goods and services needed for our standard of living.
- Like its domestic supply of fossil fuels, the nation's endowment of clean and indigenous energy resources is located in different parts of the country.
 - All of these resources – wind, biomass, solar, hydroelectric, geothermal, and energy efficiency improvements – are located in different regions of the country.
 - While some (e.g., end-use efficiency improvements) can be produced and consumed locally, others (e.g., wind, biomass, solar) offer potential resource development more plentiful than the amounts local residents can use.
 - The opportunities for clean power development often exist in areas of the country with relatively low populations and a small share of the nation's electrical demand. The American Wind Energy Association estimates that only 7 percent of the nation's population lives in the ten states that can provide most of the nation's wind potential.
- Using EHV transmission to link regions of producers and consumers offers important opportunities to tap our local energy supplies, develop local jobs, and allow access to cleaner power production in an efficient and reliable way.
- *Moving power efficiently and reliably:* EHV transmission systems move power with far lower line losses and other impacts over long distances.
 - All else equal, lower line losses mean that less overall power needs to be produced at generating stations – with less fuel consumption, lower cost, and lower environmental emissions.
 - All else equal, the ability of regions to share reserves and to back up each other's systems can lead to lower amounts of installed generation capacity needed to maintain high-performing, economical and reliable electrical systems.

- A 765-kv line requires less land used for right-of-way as compared to the multiple, lower-voltage lines that would be needed to carry an equivalent amount of power from one region to another.

Achieving the nation's requirements for clean, reliable and affordable supplies requires a new vision for an 21st Century "Interstate Electric Highway System"

- As recently as 2005, Congress articulated the national interest in ensuring a reliable and modern electric grid.
 - Those recent changes were necessary but not sufficient to focus attention on the resources and investment we need.
- And just as the nation adopted the National Interstate Highway system over 50 years ago to usher in a new era of mobility, interstate commerce and economic development, it is time to usher in a new era of electric transmission.
 - A half century ago, leaders in America launched a program to connect the cities and countryside of the United States in a national, interstate highway system. The vision was to unite the states through a web of highways, providing a foundation for national security, commerce, recreation, and development.
 - The system has sometimes been called the largest public works project in U.S. history.
 - Americans have funded the interstate highway system which now links major U.S. cities, connects workers to their jobs, and carries most of the goods and services in our country at some point along their way.
 - People and commerce move across state lines, without regard to the origins of the products or the trips, or their destinations in one state or another.
 - It is hard to imagine the shape of commerce and recreation in America in the absence of this national, interstate transportation system. And it is easy to believe that the original estimates of the system's value barely scratched the surface of the actual returns we have realized from the nation's investment in our interstate highway system.
- A parallel "interstate system" is now needed to build another critical plank in the vital infrastructure required for 21st Century American national security, prosperity and environmental progress. This one builds on a different vision of creating stronger connections to enhance the nation's electric grid and to give Americans access to the domestic energy resources vital to our national security and energy independence.
 - Like the national highway system that began with initial legs in the middle of the country, a national EHV overlay built to link the nation's heartland – with its wind, biomass, and solar resources – will help to produce economic development, strengthen energy independence, and satisfy customer demand in markets throughout the country.
 - Like the national highway system designed to connect parts of the country together, a national EHV overlay system should be funded by consumers in large electrical regions – that is, through the portions of consumers' electricity bills that reflect interstate charges rather than local rates.

- In our national highway system, we deliberately recognize in our funding mechanisms and in our terms of access that the interstate is open to all users on a non-discriminatory basis, whether those users' trips are entirely within a single state or end up crossing state lines.
- Our national policy has embraced the importance of such open access to electrical transmission, and its critical role in assuring efficient supplies of electricity in interstate commerce.
- Our funding mechanisms for a modern interstate electrical highway should align with these principles as well.
- Like the national highway system that benefitted from interstate planning and whose value was difficult to estimate at the time, a national EHV overlay should be the focus of inter-regional transmission planning efforts aimed explicitly at building a long-lived, modern system whose benefits may be realized over time in ways not imagined by today's planners and analysts.
 - We should plan a new electrical interstate highway system – encouraging interstate use, encouraging interstate support through moving transmission investment into the federal tariff, and encouraging a plan to enable broad-based geographic support for investment in transmission spanning large regions.
 - State and utility-service-territory boundaries have no more meaning for the transmission grid than they do for the transportation highway system, since electrons flow across boundaries according to laws of physics rather than laws of states, and since our electric systems rely on resources in large interconnected regions in order to provide reliable, economic, secure supply and to reduce dramatically our power sector's emissions over time.
 - Recent federal policy has shifted attention toward regional planning for electric systems. This is directionally important, and needs to move farther towards inter-regional planning for the grid. Line-by-line piecemeal investment will not support the advanced EHV interstate system we need.
 - Like the interstate highway system, electrical transmission systems are best designed as a spider web, with strength from loops and connections, rather than in small piece-meal additions.
 - Strengthening the system overall requires looking at the system as a whole. The middle of the country has many small relatively fragile systems, for example, yet very large resources for wind. Opening up those markets for clean power through EHV connections will provide benefits to the sending and receiving regions.
- Unlike the national highway system whose funding approach was criticized as having undermined the nation's support for mass transit, the development, planning, funding and siting of a national EHV overlay must occur in parallel with the other electrical improvements necessary to assure a clean, reliable, secure and economical energy supply for the country.

- This explicitly must include aggressive demand-side measures, investment in advanced metering and energy management systems, and clean power production technology.

ⁱ Susan Tierney, a Managing Principal at Analysis Group in Boston, is an expert on energy and environmental policy, regulation and economics. As a consultant, she has worked for public and private sector clients on gas and electric market issues and regulatory policy, regional transmission organizations, siting of energy facilities, energy infrastructure investment policy, policies for energy efficiency and renewables, and climate change policy. She previously served as the Assistant Secretary for Policy at the U.S. Department of Energy; the Secretary for Environmental Affairs in Massachusetts; Commissioner at the Massachusetts Department of Public Utilities; and Executive Director of the Massachusetts Energy Facilities Siting Council. She taught at the University of California at Irvine, and she earned her Ph.D. and M.A. degrees in regional planning at Cornell University. She serves on a number of boards of directors and advisory committees, including the National Commission on Energy Policy; the National Academy of Sciences Committee on Enhancing the Robustness and Resilience of Electrical Transmission and Distribution in the United States to Terrorist Attack; and the WIRES Blue Ribbon Commission on Cost-Allocation Issues for Transmission Investment. She is a member of the Advisory Council of the National Renewable Energy Laboratory, and the Environmental Advisory Council of the New York Independent System Operator. Formerly, she was a director of the Electric Power Research Institute, chaired the board of the Electricity Innovations Institute, and was a member of the Secretary of Energy’s Task Force on Electric System Reliability.

ⁱⁱ Dr. Tierney has been invited by American Electric Power to provide her assessment of the nation's energy needs, as reflected in this statement. AEP has commissioned Dr. Tierney to prepare a forthcoming white paper on the topics addressed in this initial assessment (July 2008).