TRANSMISSION AND SYSTEM PLANNING TO ENHANCE INTEGRATION OF RENEWABLE ENERGY

March 2, 2009

Presented by: Lisa M. Barton
Vice President Transmission Strategy and Business Development

Executive Summary

The Federal Energy Regulatory Commission (FERC) through a series of orders has made bold steps to open the nation's transmission system to the broad spectrum of users that depend upon the service it provides.[1] Through the facilitation of policy discussions and industry debates, FERC has put the concept of an extra high voltage (EHV) [2] interstate transmission system on the map. FERC has played and must continue to play an important role in reminding the industry and policy makers that we can enhance the reliability of the transmission grid, promote technology development and innovation, <u>in addition</u> to integrating renewables.

FERC's contributions have resulted in raising the bar and the expectations of past and present transmission systems. As we embrace the next phase of transmission reform, FERC will need to continue to encourage the development of near term transmission projects[3] to ensure that we expedite putting steel in the ground, as soon as possible. FERC should encourage regional transmission organizations (RTO) to develop robust transmission plans within and between planning regions; meaningful cost allocation methodologies which ensure broad cost support for projects that provide broad system benefits. In addition, discussions which convene utility planners, policy makers, renewable developers that focus on identifying the planning criteria, horizon and methodologies to be used, would assist in the development of an interstate transmission system. Finally, while FERC can and should continue to take a leadership role in this area, federal legislation will need to be advanced to develop the framework for planning,

---

[1] By creating open access transmission tariffs, standardizing generator interconnection protocols and agreements, adopting mandatory reliability compliance standards and enforcement, creating greater transparency in the planning process and promoting the adoption of cost allocation methodologies, FERC has begun the reformation of the nation's transmission system.
[2] Defined as 345 kV AC transmission and above; 400 kV DC and above.
[3] As FERC has provided with incentives for participation in regional planning authorities, use of advanced technologies etc.

siting and cost recovery for new EHV transmission facilities and related feeder facilities for renewable generation.

Powering the Dreams of a Nation…

The US electric industry has never before seen the level of attention that has been given both to infrastructure needs and to the future possibilities that the transmission system has to offer. There is a growing coalescence of support for an electric transmission system that provides for energy security, reliability, efficiency, environmental stewardship and energy independence. Two key means to achieve these goals have been the subject of significant debate over the past year; the development of an extra high voltage (EHV) <u>interstate transmission system</u> which is capable of bringing large amounts of renewable energy to our load centers and use of <u>smart grid technologies</u> to improve the efficiency and interactivity of the delivery network.

Today the industry is at a crossroads and significant policy decisions need to be made in order to ensure that we are able to capture the benefits of an integrated, efficient transmission system. A robust EHV backbone system and smart grid technologies are <u>both</u> essential to power the future of our nation and can be implemented in a complimentary manner which will allow these goals to be secured:

- The efficient production, transportation and use of electric energy are fundamental to the economic prosperity of the United States.
- Key policy and technical decisions need to be made on a timely basis to advance the establishment of an interstate EHV transmission system and to enable the industry to phase its development and benchmark performance.
- The EHV interstate grid should be planned taking into account availability of renewable and other clean resources and the location of load.
- Uniform EHV transmission planning protocols and criteria are needed to eliminate the technical and policy barriers associated with building an efficient EHV interstate transmission system.

The efficient production, transportation and use of electric energy are fundamental to the economic prosperity of the United States.

Enhanced energy security, reliability, efficiency, environmental stewardship, increased renewable resources and energy independence are among the expectations that we must establish for our modern transmission grid. The reality however is that our existing system is ill-equipped to meet these objectives. Today's transmission system is a product of local systems that have gradually been linked together. Evolving a system which was designed for local and regional needs, toward wide-area planning is needed to meet these challenges. To secure the goal of integrating large scale renewable resources, increasing reliability and providing a secure system in a cost effective manner is going to require a change in the way we plan the transmission system. These changes are both possible and manageable if we are determined and stay focused on the possibilities for the future rather than focusing on the perceived hurdles, of today.

Creating an EHV interstate transmission system builds upon the efficiency of the existing system by allowing lower voltage lines which are less efficient and aging to be upgraded[4] or retired. Applying smart grid technologies to the EHV system enables digital control of the EHV grid which will improve the reliability, stability and maximize the efficiency of the system. A smarter EHV grid will also allow reliable integration of large penetrations of renewable resources, which by their nature are variable and can challenge system operations.[5] With appropriate political will to get the job done, we can meet our objectives in a timely manner. The success achieved in the EHV interstate system can be complimented by the introduction of smart grid technologies in the distribution delivery network and two-way communication with customers is enhanced, the efficiency and the reliability of the entire transmission and distribution system can be secured.

Key policy and technical decisions need to be made on a timely basis to advance the establishment of an interstate EHV transmission highway and to enable the industry to phase its development and benchmark performance.

Within the past 24 months we have witnessed unprecedented volatility in oil prices, major economic turmoil and growing concern for reducing CO2 emissions. This has led to increased pressure to enhance our energy independence, increase the potential for renewable development, to grow our economy and to make the production, transportation and consumption of energy as efficient as possible. Strategic expansion of the transmission grid, including development of a robust national EHV interstate transmission system will better prepare the US to address the limitations of the current system, provide opportunities for the rapid integration of renewables and spur the development and integration of smart grid technologies. However the way in which we plan the system today needs to change dramatically if we are to be successful. The present paradigm is a fragmented approach to transmission planning, which is unworkable when attempting to extend EHV transmission beyond the borders of an individual planning region.

Today's system, whether planned by an individual utility or through a regional transmission organization, is planned on rigid and often myopic reliability and economic criteria that are based on specific but limited planning horizons and objectives. The magnitude of these criteria and objective impediments, however vary at the utility, state or regional level.

Today our solutions are limited by the scope of the analyses conducted and planning criteria used by the respective organization/utility. This creates a significant hurdle for projects that are located between two different planning regions and those designed for diverse and broad regional benefits.[6] Ensuring that the EHV system, a system that

[4] Today it is becoming increasingly difficult to schedule the needed outages to upgrade or maintain aging transmission lines. Operationally, these overtaxed transmission lines are needed to maintain system reliability, often resulting in outages needed to be postponed months or years out and scheduled during the shoulder seasons, when customer demands are moderate.

[5] Applying new communication technologies to enhance the operability and performance of the grid can provide region wide benefits.

[6] Federal policies have encouraged the development of regional planning. While this is directionally important, it needs to move farther towards inter-regional planning for the establishment of robust interstate

provides regional and interregional benefits is planned in a consistent and holistic manner, in a way that directly targets the goals outlined above is an essential first step. A step that while simple, deviates from how transmission is currently planned and requires the industry to make a change.

The EHV interstate grid should be planned taking into account availability of renewable and other clean resources and the location of load.

The integration of large scale renewable resources has been at the forefront of discussion and policy debates. When we address the integration of renewables from a transmission planning perspective, highlighting the differences between traditional generation resources and renewable resources is foundational to understanding how the EHV interstate transmission system should be planned.

What do we know…..

First the good news! We know where the wind blows and where the sun shines! We also know where our load centers and population bases are located. These are two critical points when trying to plan a national EHV transmission system! The most significant difference between renewable resources and fossil fired resources is predictability in the location. While a fossil fired plant could readily be located near existing transmission, renewable (wind, solar and hydro) plants need to be located where their energy sources are located. Our wind and solar resources are unique in that their potential far surpasses the capacity of other renewables and their location is more remote. Therefore, efficient transmission lines are needed to connect wind rich areas to our load centers in an efficient manner in order to maximize the output potential of these resources, ensure the stability and reliability of the new and existing transmission grid and delivers these resources in a timely and cost effective basis.

Consider the possibilities……

In 2008 the United States made tremendous progress in terms of integrating new wind energy, but it is important to put that fact in context. While the US surpassed Germany, the US wind potential is nearly six times as great.[7] Our sheer geographic size is 23 times as large. The US transmission system needs to be modified to maximize efficiency through the development of a robust EHV grid to meet US needs.

EHV transmission system. While there are several regional and state-level planning initiatives are currently underway in various parts of the country and focus on development of transmission to transport renewable energy. These initiatives can serve as the platform for planning the new grid but a national entity is needed to develop a truly coordinated plan for transmitting renewable energy and to approve and build EHV transmission lines. Today projects that are proposed between planning regions run the risk of being islanded, in that they do not neatly fall into the planning criteria of either region. To develop a true interstate transmission grid, uniformity in the planning criteria, goals and assumptions are necessary.

[7] Figure excludes solar availability.

Transmission Planning: Using a System Approach

UNITED STATES*
Population
303 Million

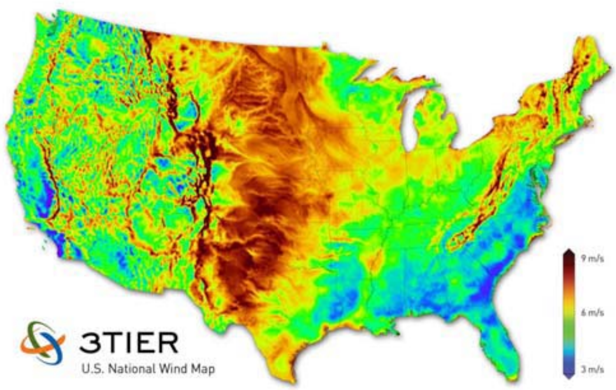
Square Miles
3,119,884 sq mi

Peak Load
782 GW**

Annual Consumption
3,890 billion kWh

Wind Connected
25,105 MW installed
49 TWh produced

Wind Capacity***
300 GW
5.8 billion MWh by 2020
(20% (20% Scenario)
**Contiguous US*
***Non-Coincident*
****Based on feasibility studies*



GERMANY
Population
82 Million

Square Miles
137,847 sq mi

Peak Load
80 GW

Annual Consumption
550 billion kWh

Wind Connected
23,903 MW installed
39.5 TWh produced

Wind Capacity***
55 GW
150 TWh by 2020
(25% Scenario)

"The U.S. wind energy industry shattered all previous records in 2008 by installing 8358 MW of new generating capacity." ***American Wind Energy Association***

Time is of the essence……
We also know that it takes, on average, two years to develop a wind project and up to five years to build needed EHV transmission. EHV by its nature takes longer to build than lower voltage transmission projects. When we look at solutions from a systems based approach, by knowing the wind potential, its location and the location of our load centers, we can identify the interstate system and the major on ramps needed to harvest those resources before the wind has been developed. By planning the system in such a manner, we can integrate the lower voltage feeder lines (which take less time to construct) as generation projects are developed.[8] One common denominator of any industry is the need for predictability. This integrated approach will provide greater predictability to and allow both utilities and renewable developers to understand where to focus and plan their efforts. In addition, there would be more information provided to states and the federal government to understand with a greater level of accuracy the level of renewables available to satisfy Renewable Portfolio Standards (RPS) requirements.

Reliance on the past is the most significant barrier to interconnection wide planning…
To develop an interstate transmission "system" we need to apply broad and strategic views to transmission planning. We need to move away from the traditional RTO and utility based planning which builds the system on a line by line basis, considering only

[8] By separating the development of feeder lines from the development of an EHV overlay, greater coordination can be secured between the development of renewable generation plants and the feeder lines that will provide them with access to the interconnected grid.

reliability needs, often one line at a time. We need to immediately start to develop an "integrated EHV transmission system". The ***system*** needs to be justified, not each of the individual pieces. In this case, the whole is truly greater than the sum of the parts.

Transmission solutions have traditionally been a "solution of last resort".[9] While RTO's have applied a more regional approach to transmission planning these efforts still tend to promote transmission as a last resort effort. Also today planning efforts end at the borders of the RTO or transmission owner. When transmission is planned in this manner, the solutions themselves become severely limited. We miss opportunities to look at building a double circuit EHV line today for concerns over the cost allocation even when from an engineering perspective it is the right investment to make over the long term.[10] We miss opportunities to develop more robust solutions because our planning criteria limit new projects to only those needed for reliability, thereby forgoing a project that would provide economic benefits or enhance the integration of renewables.

At a high level, AEP believes the following changes need to be made:

- Adoption of a single, interconnection wide set of planning criteria and assumptions which can be used to develop interconnection wide EHV plans. The plans should focus on a "system solution" which takes into consideration:
    - Reliability
    - Maximizing renewable integration & RPS goals
    - Resource sharing[11]
    - Market efficiency
    - Right of way mitigation
    - Uncertain/dynamic future requirements
    - Demand-side options[12]
    - Transmission costs
    - Delivered cost of energy[13]
- EHV projects should be evaluated in a balanced manner which recognizes their long term value and which provides predictability in the development of EHV

[9] Because the vast majority of transmission planning processes in use today, evaluate the need for a projects based on a reliability need only, in most RTO's a transmission line can be deferred if local generation is available or if demand decreases such that the project can be replaced by generation or deferred in time. By using this approach when all other solutions (generation, load reduction etc) can derail a transmission project, transmission becomes the solution.

[10] E.g. *"PacifiCorp's priority is building Energy Gateway for our retail customers. Our preference is to build it to also accommodate regional needs. We continue to do what is possible to make it work for the region, but only if others are willing to share the cost and risk. PacifiCorp is actively seeking committed participants to "supersize" the project to double-circuit 500 kilovolt for certain segments, but will also move forward with single-circuit construction if these parties cannot commit in time."* PacifiCorp, "Energy Gateway - Bringing new transmission to the West", July 2008. (www.pacificorp.com)

[11] Cost savings associated with resource sharing benefits provided by a tightly integrated EHV system can be significant.

[12] Including demand projections, conservation initiatives, smart grid technologies, electrification of the transportation sector (e.g. Plug-in hybrid electric vehicles and electric vehicles) and industrial processes.

[13] Through strategic investment in an EHV interstate transmission system, we can advance the policy goals as outlined above and reduce the delivered cost of energy by reducing resource requirements, losses, and providing greater access to low cost renewable resources.

lines. Planning processes or analyses which focus on delaying EHV projects need to be avoided in order to provide renewable developers with certainty, that transmission will be available within a defined period of time.[14]

- Broad based cost support for an EHV system. *While this is not a technical planning issue, it is at the heart of what limits the scope of our technical solutions!*
- Adoption of planning criteria and assumptions used to develop the necessary feeder lines to collect the renewable resources.

While there are differences between the interconnections, applying an interconnection wide planning process with the goal to link the east and west system is both feasible and necessary….

The existing interconnects are the result of electric systems that grew from east to west, and west to east. The result is a weak system in the upper Midwest and the southwest (SPP area) and the current inability to link these interconnections together due to their sheer geographic size. Despite this history, there is the possibility with time and through proper development to allow these systems to interconnect on a permanent or a temporary basis.

Planning for the future….

It is critical at this juncture as we consider the policies outlined above and the direction that we take, that we pause to consider the long term nature of transmission investments. We need to avoid the natural human tendency of being reactionary based on information that is available at a snap shot in time. The EHV interstate transmission system that we will build will be in operation throughout the next century. There will invariably be technologies and generation sources available to us that are beyond those we are discussing today, many that we may not even be able to envision as we hold these discussions and make decision for the future of the US grid. The definition of a grid is an interconnected system for the distribution of electricity over a wide area. For this reason it is <u>imperative</u> that the ***system*** we design today be adaptive and efficient to meet our future needs. We must avoid the temptation to be unduly limited in the scope of the solution and the resources we will be relying upon over the coming decades.

Uniform EHV transmission planning protocols and criteria are needed to eliminate the technical and policy barriers associated with building an efficient EHV interstate transmission system.

Our performance to date speaks volumes. We have only just begun to harvest the wind and solar potential that we have available and have been able to successfully interconnect some of the low hanging fruit that is available to us. We are embroiled in the debate of what comes first; the wind or the transmission. Should we focus on smart grid distribution technologies before developing an EHV grid? Meanwhile, the vast majority of these resources remain untapped with no near term possibility of improving the situation at hand without decisive action to build an interstate EHV grid. We need to

[14] Today, many RTO planning processes fail to recognize benefits other than reliability. As such, projects can become cancelled or deferred because the scope of the solution being sought is limited.

recognize the time it takes to build transmission. We need more than discussion and debate. We need decisive action which would call for the phased development of an EHV grid that can power the dreams of a nation.

FERC orders have made the planning process more transparent and open…..
FERC order 888 and its companion orders, including order 890 have done much to open the transmission system to new generator sources and increase the transparency of the planning process; however, more is needed. We need to change how the system is planned. Without a cohesive approach to EHV planning these resources will at best trickle into our portfolio. Wind plant development has suffered from what has been called the chicken and egg dilemma surrounding wind integration. For fear of our concern of "over building" we have historically shunned away from building the transmission first. However, if we encourage the developed of an integrated EHV system even those lines can still provide significant benefits, even if the wind potential is not as great as we expect it to be. If we properly consider the time it takes to build EHV transmission, the fact that transmission can be coordinated and planned to provide the needed certainty to renewable developers, much can be done to further the integration of renewables.

Integrating large scale renewable resources requires a backbone grid…
One of the challenges often cited as a concern with integrating renewables is the variability of their output. By ensuring a robust, well planned grid with integrated smart grid technologies, we can maximize the output while ensuring reliable system operation.

In the seven state region of AEP's east companies[15], we have an example of a well functioning interstate transmission system. Within this region there are 2100 miles of 765kV transmission which provides broad based benefits to the PJM system. Unlike many areas around the country, the AEP 765 kV system does not experience congestion or other constraints. EHV systems like AEP's 765 system are ideal for the integration of wind because it can be more adaptive than lower voltages in absorbing the variable output of wind resources.[16] In addition, the 2003 Northeast blackout stopped at AEP's doorstep-a demonstration of the resiliency of a robust EHV backbone system. In part because of AEP's decision to move to a robust backbone system, AEP's transmission costs remain the lowest among its comparable peers.[17] The decision to use EHV lines was to enhance the efficient movement of energy across large geographic areas and ensure the efficient delivery of energy to remote load centers. This real world example demonstrates what's possible for the nation on a larger scale!

---

[15] AEP Ohio, Appalachian Power (in Virginia, West Virginia), AEP Appalachian Power (in Tennessee), Indiana Michigan Power, and Kentucky Power

[16] By their nature, EHV systems have a significant advantage with respect to maximizing the output of renewable resources. EHV systems can more readily absorb increases or decreases in the output of these facilities since this variability can be more effectively balanced across a large geographic area. In addition, challenges associated with large scale wind integration such as VAR control can be mitigated by allowing this support to be provided elsewhere on the system.

[17] In 2007, AEP was the lowest cost transmission provider among its peers in terms of capital and O&M spent per line mile, while operating the highest voltage, most efficient system in the country.

Concerns over transmission costs overshadow the bigger picture....
Transmission accounts for less than 10%[18] of the customer's bill, and even large investments have little impact on the customer bill. Further, significant savings can be realized through transmission investment. Integration of lower production cost generation, lower system losses, and reduced congestion facilitated by EHV transmission all benefit the customer, yet we tend to focus on minimizing this little transmission slice of the pie rather than the overall cost of delivered energy. This overall cost can be reduced through EHV transmission expansion combined with large-scale integration of renewables.

CONCLUSION

Building an EHV interstate transmission system and applying smart grid technologies to that system will maximize the integration of renewable resources and will further the development of smart grid technologies on a broader scale over time. While there are significant regional variances, on average the United States has one of the lowest electricity costs in the world. At the same time, we have renewable resources available to us which are currently beyond our reach. The approach to transmission planning outlined above can provide a strong platform which can further the policy objectives noted and grow our country’s infrastructure in a timely and prudent fashion.

AEP commends the leadership role that FERC has taken with respect to transmission issues. We encourage FERC to continue in its efforts to raise the bar and the expectations of the transmission system, as we discuss issues of transmission planning and the construction of a robust, sustainable EHV interstate transmission system. AEP believes strongly in the vision of a robust and versatile grid and encourages legislative members, FERC and other policy makers to take the steps needed to attain the goals outlined above. The strategic initiatives laid out by FERC, will serve as guideposts for the new foundation of integrated transmission reforms of the future.

[18] Energy Information Administration, Annual Energy Outlook 2008 with Projections to 2030 (Energy Information Administration, 2008), 131, (http://www.eia.doe.gov)

American Electric Power Inc.
1 Riverside Plaza
Columbus, OH 43215

<u>CONTACTS:</u>
Michael G. Morris, Chairman, President and Chief Executive Officer
614-716-1100; mgmorris@aep.com

Susan Tomasky, President - AEP Transmission
614-716-1600; stomasky@aep.com

Michael Heyeck, Senior Vice President – Transmission
614-552-1700; mheyeck@aep.com

Lisa M. Barton, Vice President - Transmission Strategy & Business Development
614-552-1620; lmbarton@aep.com

AEP AMERICAN® ELECTRIC POWER