Comments of Americans for a Clean Energy Grid and Supporters to the Department of Energy on the Quadrennial Energy Review (QER) Report on Energy Transmission, Distribution and Storage October 10, 2014

High Voltage Transmission: America's Indispensable Investment for a Clean Energy Future

Americans for a Clean Energy Grid[1] (ACEG) and its supporters[2] welcome the opportunity to provide input to the Quadrennial Energy Review (QER). Our message is simple: we urge the Department of Energy and the Administration to include among the report's highest priority recommendations policy reforms to rapidly expand, integrate, and modernize the nation's high-voltage transmission system.

Robust infrastructure networks have enabled economic and social "quantum leaps" throughout American history: inland waterways, railroads, highways, telecommunications networks, and the internet. The National Academy of Engineering recently ranked electrification of our nation as the 20th century's greatest engineering achievement – ahead of numerous other extraordinary advances like automobiles, airplanes, telephones, computers, radio and television, and highways[3]. Electricity is the lifeblood of the global economy and a necessity of modern life, and universal access to affordable, reliable, and environmentally sustainable electricity is fundamental to the general welfare of citizens everywhere. Safe, precise, economic, and efficient, electricity is steadily displacing other forms of direct energy use in nearly every sphere of industrial, commercial, and consumer activity, from manufacturing, agriculture, and retail to health care, education, and entertainment. And with the urgent need to reduce carbon emissions in every sector of the economy, electricity is poised to become equally important and ubiquitous in personal transportation. Electric devices are even indispensable to the extraction, delivery, and use of every other major energy resource.

[1] Americans for a Clean Energy Grid is a project of the Energy Future Coalition which supports policies to modernize and expand the nation's electric transmission network and unlock clean energy and economic opportunities across the country. The backbone of a clean electricity system and a strong economy is a resilient and reliable transmission grid. Smart state and federal policies that improve the way the grid is developed, planned, and paid for will help it become a more robust, reliable, and secure network that supports expansion of renewable energy, competitive power markets, energy efficiency, and lower costs for consumers.

[2] Organizations supporting this set of comments include: the WIRES Group, the Natural Resources Defense Council, the Sustainable FERC Project, Clean Line Energy Partners, Fresh Energy, and The Climate & Energy Project (Kansas). Additional supporters can be found at www.cleanenergytransmission.org.

[3] National Academy of Engineering, *Greatest Engineering Achievements of the 20th Century*, 2000.

The backbone of this amazing energy source is the nation's high voltage transmission network. It is at once both reliable and efficient but also badly in need of expansion and modernization. Customers in the U.S. can expect to experience between 1.5 and 2 power interruptions per year and between 2 and 8 hours without power[4]. Losses[5] from transmission and distribution decreased from more than 16% in the late 1920s to less than 7% in 2009[6], but they are greater under peak conditions and are reduced when loads are stable. At just 11%, transmission is the smallest part of the average consumer's bill, far less than the 58% for generation and 31% for distribution[7].

Despite this remarkable track record, decades of underinvestment have left the nation's high voltage transmission network vulnerable to diverse threats including storms, terrorism, and failure of critical components like transformers, substations, and towers nearing the end of their useful lives. Annual investments in high voltage transmission by investor owned utilities began to drop sharply in the early 1980s, bottoming out in the late 1990's almost 50% lower than prior levels.

More than two thirds of the nation's extra high voltage lines and transformers are 25 years or older, and there is no domestic manufacturing capacity for any high voltage transformers 345 kV[8].

Over the past two decades, Administrations of both parties and Congress have recognized the need to incentivize transmission expansions and upgrades, and have taken numerous legislative and regulatory actions to address the issue. These policies have borne fruit: by 2013 investments in high voltage transmission had recovered most of the ground lost in the 1980s and 1990s. Unfortunately, the Edison Electric Institute now predicts that transmission investments likely peaked in 2013 and will begin to decline in 2014 and beyond. Simply modernizing the existing high voltage transmission network would require sustaining current levels of transmission investment for a decade or more; building interregional links needed to accommodate very high levels of renewable energy would require significant additional investments.

Expanding *and* modernizing the nation's high voltage transmission network is essential to achieving national economic and environmental goals. Specifically, the rapid, large scale deployment of renewable energy necessary to meet long term greenhouse gas targets will require a high-voltage transmission network capable of:

(1) Accessing the best quality and largest renewable energy resources, which are concentrated in remote regions far from population centers.
(2) Balancing the natural variability of renewable resources, which has been shown to be much easier when large regions are integrated.
(3) Delivering affordable, reliable, and clean electricity to consumers in every part of the country.

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[4] Massachusetts Institute of Technology, *The Future of the Electric Grid: An Interdisciplinary MIT Study*, 2011.
[5] The fraction of energy generated that is lost due to heating of transmission and distribution lines and of other components.
[6] Massachusetts Institute of Technology, *The Future of the Electric Grid: An Interdisciplinary MIT Study*, 2011.
[7] U.S. Energy Information Administration, *Annual Energy Outlook 2012*, Reference Case, Table 8: Electrical Supply, Disposition, Prices, and Emissions.
[8] "Meeting our Energy Goals: The Energy Superhighway," Joseph L. Welch, April 13, 2010.

The QER represents a rare opportunity for DOE to draw attention to the most urgently needed and difficult to build transmission investments: interstate and interregional lines which tap large, remote, high quality renewable resources and/or link/consolidate balancing areas and markets. The remainder of our comments highlights the central elements of our argument for accelerating the expansion and modernization of the nation's high voltage system.

High voltage transmission expansions and upgrades deliver diverse benefits: making the grid more reliable, secure, and resilient, giving consumers broad access to diverse low cost, low carbon resources, and enabling efficient and competitive electricity markets.

Regulators, planners, and diverse stakeholders increasingly recognize that high voltage transmission investments generate benefits far beyond traditional categories like production cost savings, improved reliability, and congestion relief. Quantifying every type of transmission benefit is technically challenging, especially when one considers the long life of high voltage assets and the complexity of the network. Nonetheless, the systematic omission of entire categories of benefits unquestionably contributes to the well-documented and chronic underinvestment in high voltage transmission. A 2013 report commissioned by the WIRES Group[9] strongly recommended that planners consider a much more comprehensive suite of transmission benefits, specifically:

1. Traditional Estimates of Production Cost Savings
2. Additional Production Cost Savings
    - Reduced transmission energy losses
    - Reduced congestion due to transmission outages
    - Mitigation of extreme events and system contingencies
    - Mitigation of weather and load uncertainty
    - Reduced cost due to imperfect foresight of real-time system conditions
    - Reduced cost of cycling power plants
    - Reduced amounts and costs of operating reserves and other ancillary services
    - Mitigation of reliability-must-run (RMR) conditions
    - More realistic representation of system utilization in "Day-1"markets
3. Reliability and Resource Adequacy Benefits
    - Avoided/deferred reliability projects
    - Reduced loss of load probability or
    - Reduced planning reserve margin
4. Generation Capacity Cost Savings
    - Capacity cost benefits from reduced peak energy losses
    - Deferred generation capacity investments
    - Access to lower-cost generation resources
5. Market Benefits

[9] "The Benefits of Electric Transmission: Identifying and Analyzing the Value of Investments," Judy Chang, Johannes P. Pfeifenberger, and Michael Hagerty, WIRES, July, 2013.

- Increased competition
- Increased market liquidity

6. Environmental Benefits
   - Reduced emissions of air pollutants
   - Improved utilization of transmission corridors
7. Public Policy Benefits - Reduced cost of meeting public policy goals
8. Employment and Economic Development Benefits
   - Increased employment and economic activity
   - Increased tax revenues
9. Other Project-Specific Benefits
   Examples: storm hardening, increased load serving capability, synergies with future transmission projects, increased fuel diversity and resource planning flexibility, increased wheeling revenues, increased transmission rights and customer congestion hedging value, and HVDC operational benefits.

Regulators and planners have taken positive steps in recent years to more fully account for the benefits of proposed transmission expansions and upgrades, but methodologies still vary widely from region to region, and no planning authority has yet embraced an approach which includes all potential benefit categories, such as those enumerated above by the authors of the WIRES report. Limiting the scope of benefits considered inescapably leads to the rejection of beneficial projects, and ultimately higher costs for consumers. Many benefits of the modern integrated grid, such as competitive electricity markets and the development of large scale renewable resources, were scarcely imagined when most high voltage facilities were built decades ago. For example, the value of increased competition and reduced system losses alone can exceed 50 percent of a transmission project's costs[10].

In regions with competitive wholesale electric markets, coordinated investments in transmission and renewable generation leverage market forces to drive more expensive and higher emitting resources out of the market. The economic and environmental benefits from simultaneously increasing renewable energy penetration and lowering prices for consumers are impressive. A May 2013 study by Synapse Energy Economics on behalf of Americans for a Clean Energy Grid (ACEG) found that doubling the wind generation already planned in PJM, the largest wholesale competitive energy market in the world, which includes all or parts of 13 states and Washington, D.C., would lower fuel costs and drive down prices by $1.74 per megawatt hour (MWh). Net savings to PJM customers would approach $7 billion per year in the mid-2020s – after paying for transmission investments need to connect the additional wind, with additional savings extending into regions interconnected with PJM[11].

Considering the full range of benefits of transmission expansions and upgrades is a critical first step toward making better decisions about which lines to build and when to build them, which will put us in the best position to meet our national economic, environmental and security goals.

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[10] "Transmission's True Value." By J.P. Pfeifenberger and D. Hou, Public Utilities Fortnightly, February, 2012.

[11] "The Net Benefits of Increased Wind Power in PJM," by Bob Fagan, Patrick Luckow, Dr. David White, Rachel Wilson, Synapse Energy Economics, May, 2013.

Remote renewable resources are larger, higher quality, and less expensive than renewable resources close to load, and are the only resources capable of meeting long term greenhouse gas emissions targets in a cost-effective and timely manner.

The National Renewable Energy Laboratory (NREL) estimates the technical potential in the United States of utility-scale PV [photovoltaic] and CSP [concentrating solar power] at approximately 80,000 GW and 37,000 GW, respectively. NREL estimates the technical potential of distributed rooftop PV technologies at approximately 700 GW – less than 1% of the utility scale resource.[12]

Wind power in onshore locations comprises the vast majority of both installed non-hydro renewable capacity and actual generation, and is almost entirely utility scale, primarily due to resource quality and economies of scale[13]. Larger turbines are more efficient, and project costs fall when turbines are sited in large groups. Small scale wind turbines (100 kW or less) cost more than four times as much per unit of installed capacity as larger ones[14].

According to the most recent data from the Solar Energy Industries Association (SEIA), utility scale solar PV costs $1.69 per watt of installed capacity, less than half of the $3.74 per watt for residential systems.[15] Despite their overwhelming resource size and cost advantages, utility scale PV projects account for only half of the installed PV capacity in the United States, primarily due to transmission constraints which prevent more aggressive development of large scale PV. Utility scale projects are gaining ground, representing a majority of new PV capacity for five straight quarters – more than residential and commercial installations combined. Solar PV growth in recent years has been impressive, but the massive potential of U.S. solar resources will only be unlocked when transmission infrastructure is in place.

Offshore wind is a large, high quality resource located close to population centers, but costs about three times as much as onshore wind per unit of installed capacity. Only 6.8 GW of the 321 GW of global wind capacity installed by the end of 2013, about 2%, was offshore[16], and the bulk of this capacity is in Europe, where a combination of high electricity prices, limited onshore wind resources and high voltage infrastructure, and generous government subsidies create a much more favorable economic environment.

While there are many potential paths to achieving medium term greenhouse gas targets (e.g. the 30 percent reduction in power sector carbon emissions by 2030 recently proposed by EPA), there are no economically feasible paths to much steeper science-based greenhouse gas targets (80 percent or more

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[12] *Renewable Electricity Futures Study (Entire Report)* National Renewable Energy Laboratory. (2012). Renewable Electricity Futures Study. Hand, M.M.; Baldwin, S.; DeMeo, E.; Reilly, J.M.; Mai, T.; Arent, D.; Porro, G.; Meshek, M.; Sandor, D. eds. 4 vols. NREL/TP-6A20-52409. Golden, CO: National Renewable Energy Laboratory. http://www.nrel.gov/analysis/re_futures/

[13] 2011 Cost of Wind Energy Review, National Renewable Energy Laboratory, March 2013.

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[15] Modeled turnkey pricing for installed solar photovoltaic systems, by sector, Q2, 2014. U.S. Solar Market Insight: Q2, 2014, Solar Energy Industries Association, September, 2014.

[16] Ryan Wiser and Mark Bollinger, *2013 Wind Technologies Market Report*, Lawrence Berkeley National Laboratory, U.S. Department of Energy, August, 2014.

by 2050) which do not rely on massive deployment of renewable energy. America has enough renewable resources to meet even these ambitious targets dozens of times over, but developing and delivering them will require a robust national high-voltage transmission network. Renewable energy generation can be deployed quickly, but under current policies high voltage transmission lines take a decade or more on average to plan and build, and interstate and interregional lines face even longer and more uncertain timeframes. Meeting long term greenhouse gas emissions targets will likely be impossible unless interstate and interregional high voltage transmission can be planned, paid for, and built much faster than is possible under current policies.

High voltage transmission is essential to developing remote renewable resources at scale.

Nearly every comprehensive analysis of how to transition from our current fleet of fossil fuel power plants to an electric system primarily powered by renewable resources reaches the same conclusion: high voltage transmission is absolutely essential. In 2011, the Massachusetts Institute of Technology's interdisciplinary Future of the Electric Grid study[17] offered this summary:

> "One of the most important emerging challenges facing the grid is the need to incorporate more renewable generation in response to policy initiatives at both state and federal levels. Much of this capacity will rely on either solar or wind power and will accordingly produce output that is variable over time and imperfectly predictable, making it harder for system operators to match generation and load at every instant. Utilizing the best resource locations will require many renewable generators to be located far from existing load centers and will thus necessitate expansion of the transmission system, often via unusually long transmission lines. Current planning processes, cost-allocation procedures, and siting regimes will need to be changed to facilitate this expansion."

A year earlier, in 2010, the European Climate Foundation reached a remarkably similar conclusion in their Roadmap 2050 analysis[18], which looked at how Europe could reduce carbon emissions from the electricity sector by more than 80 percent by 2050:

> "Compared to today, all of the pathways, especially those with higher RES penetrations, require a shift in the approach to planning and operation of transmission systems. Electricity demand is no longer fixed and unchangeable. 'Smart' investments that make demand more flexible and responsive to the available supply of energy can significantly reduce system costs and implementation challenges. Expansions of transmission system capacity are a crucial and cost-effective way to take full advantage of the low-carbon resources that are available, when they are available. Inter-regional transmission must develop from a minor trading and reserve-sharing role to one that enables significant energy exchanges between regions across the year,

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[17] *The Future of the Electric Grid: An Interdisciplinary MIT Study*, Massachusetts Institute of Technology, 2011.

[18] *Roadmap 2050: A Practical Guide to a Prosperous, Low-Carbon Europe, Technical Analysis, Executive Summary*, European Climate Foundation, April, 2010.

> enabling wider sharing of generation resources and minimizing curtailment. Operation of the grid must be based on greater collaboration over wider areas. To achieve this, it is paramount that planning and evaluation of transmission investments and operational decisions consider wider regional benefits than is currently the case."

In 2012, DOE's National Renewable Energy Laboratory added significantly to the growing body of research supporting the essential role of high voltage transmission in reaching high levels of renewable energy penetration with this conclusion from their Renewable Electricity Futures Study[19]:

> "As renewable electricity generation increases, additional transmission infrastructure is required to deliver generation from cost-effective remote renewable resources to load centers, enable reserve sharing over greater distances, and smooth output profiles of variable resources by enabling greater geospatial diversity."

Evidence is growing that "transmission first" policies are key to achieving rapid, large scale development of high quality and cost-effective renewable energy resources.

The largest and most cost effective renewable energy development in the U.S. has occurred in states and regions where policy makers and transmission planners have taken proactive steps to build transmission with the explicit goal of developing renewable energy in mind. The best examples of how transmission planning is directly enabling renewable energy development in the U.S. are Texas, MISO and California, each described in further detail below. Together, these three states/regions accounted for about half of U.S. installed wind capacity at the end of 2013.

- ***Competitive Renewable Energy Zones (CREZ) project in Texas***
  The CREZ comprises 3,600 circuit miles of transmission lines designed specifically to accommodate 18,500 MW of wind power capacity to meet the Texas RPS, and was largely completed in 2013. Texas already leads the nation in installed wind capacity (and installed renewable energy capacity) by a wide margin, with 12,354 MW installed at the end of 2013 – more than twice as much as California (5829 MW) in second place. The Electricity Reliability Council of Texas (ERCOT) predicts that over 7,000 MW of new wind capacity will be installed in Texas by the end of 2015, with another 1,300 MW projected to come online in 2016. Total wind capacity will therefore significantly exceed the CREZ goal of 18,500 MW, and well ahead of schedule. The CREZ transmission lines have reduced wind curtailment by more than 90 percent, from 3782 GWh in 2009 (17.1% of potential wind generation) to just 363 GWh in 2013 (1.2% of potential wind generation), while at the same time effectively eliminating wind-related congestion between West Texas and other parts of the state. At $6.8 billion, the CREZ exceeded initial cost estimates by $2 billion, due to both inflation and the need to add over 600 circuit miles of additional transmission to accommodate routing changes requested by landowners.

[19] *Renewable Electricity Futures Study*, Trieu Mai, Debra Sandor, Ryan Wiser, and Thomas Schneider, National Renewable Energy Laboratory, July, 2012.

Despite these higher costs, ERCOT expects the benefits of the CREZ transmission lines will far exceed their costs to ratepayers.

- ***MISO Multi Value Project Portfolio (MISO MVP)***
  In 2011, the Board of Directors for the Midcontinent Independent System Operator (MISO) approved the development of seventeen 345 kV transmission lines across nine states, to be placed in service between 2014 and 2019, at a cost of $5.2 billion. The agreement to build the portfolio was the result of a decade-long planning process that engaged state regulators, utilities, customers, environmental advocates, landowners, and many other interested parties. Comprehensive economic analysis of the MVP lines by MISO staff predicted that they would generate reliability, public policy and economic benefits far exceeding their costs in every part of the vast MISO footprint, specifically, the lines would:
  - Provide an average annual value of $1,279 million over the first 40 years of service, at an average annual revenue requirement of $624 million, with benefit to cost ratios ranging from 1.8 to 3.0 in all scenarios studied.
  - Enable development and delivery of 41 million MWh of wind energy generation per year to meet renewable energy mandates and goals.
  - Improve system reliability by resolving violations on approximately 650 elements for more than 6,700 system conditions and mitigating 31 system instability conditions.[20]

  MISO's 2014 analysis of the MVP lines, based on much more current information, finds that they are likely to an even better investment than originally believed:
  - Net benefits of the lines increase by approximately 50 percent over the 2011 analysis to $13.1 to $49.6 billion over the next 20 to 40 years.
  - Benefit-to-cost ratios grow to 2.6 to 3.9 – a dramatic increase over the 1.8 to 3.0 range calculated in 2011, despite a slight increase in project costs.
  - The projects will enable 43 million MWh of wind energy to meet state renewable energy mandates and goals through 2028, 2 million MWh more than the 2011 forecast[21].

- ***California Renewable Energy Transmission Initiative (RETI)***
  RETI is a statewide initiative to help identify the transmission projects needed to meet California's aggressive renewable portfolio standard of 33% by 2020. RETI was designed as an open, transparent, and collaborative process to encourage participation by all interested parties in facilitating the designation of transmission corridors and in the siting and permitting of both transmission and generation. RETI has assessed competitive renewable energy zones in California and neighboring states to identify resources that can meet the 2020 goal in the most cost effective and environmentally benign manner. In 2009, RETI identified more than $15.7 billion in transmission expansions and upgrades which would allow California to meet the RPS

[20] MISO Multi Value Project Portfolio Results and Analysis (January, 2012)

[21] MTEP14 MVP Triennial Review: A review of the public policy, economic, and qualitative benefits of the Multi-Value Project Portfolio, Midcontinent Independent System Operator, September, 2014.

goal by 2020. Many of these lines offer additional reliability, congestion relief, and economic benefits, so their cost cannot be attributed entirely to meeting the RPS goal.

- ***Southwest Power Pool (SPP) Highway/Byway Cost Allocation***
  SPP developed and adopted a highly simplified approach to allocating the costs of transmission facilities to bypass arguments over who should pay for what which frequently delay beneficial transmission investments for years or even decades. The "Highway-Byway" cost-allocation methodology, approved by FERC in 2010, allocates transmission facility costs based on facility voltage, consistent with the common sense notion that higher voltage facilities will benefit large regions, while lower voltage lines will deliver more localized benefits. For projects of 300kV and above, all costs are allocated on a uniform (i.e., "postage stamp") basis equally across the entire SPP region. For projects below 300kV but above 100kV, one-third of the cost is allocated on a regional basis, and the remaining two-thirds of the cost are allocated to the SPP zone where the facilities are located. For projects of 100kV or less, all costs are allocated to the zone where the facilities are located. SPP's first 20-Year Integrated Transmission Plan Assessment, completed in January, 2011, estimates that the nearly 1500 miles of 345 kV lines and 11 transformers in the plan will reduce the cost of generating and supplying energy by more than five times their $1.8 billion engineering and construction cost, while simultaneously giving the region the flexibility to respond to policy initiatives like carbon regulation cost effectively and without disruptions[22].

Impacts of essential transmission investments on sensitive resources can be reduced and approvals expedited by defining renewable energy zones, using information to anticipate and avoid resource conflicts, and engaging stakeholders.

Although the environmental and public health costs of power plant emissions dwarf those of high voltage transmission lines, the deployment of large physical infrastructure always incurs environmental impacts. Towers and lines change the visual landscape, impact local property values, and can affect sensitive habitats. Corridors cleared of vegetation, which are needed for safety, security, and maintenance access, can disrupt wildlife, agriculture, and recreation.

Pre-screened zones for renewable energy can slash the time to market for new generation. By streamlining siting hurdles for large groups of transmission and generation projects, renewable energy zones help government agencies to prioritize projects, assess impacts efficiently, and bring new infrastructure online more quickly. The Texas CREZ project provides strong evidence of the effectiveness of renewable energy zones, as it has made the state the runaway national leader in installed renewable energy capacity (see above.) California, Arizona, Colorado, Nevada, Utah have since

[22] "SPP Approves Transmission Plan for the Year 2030, Further Development of New Energy Markets," Southwest Power Pool, Press Release, January 26, 2011.
http://www.spp.org/publications/ITP20_Marketplace_Development_Approved.pdf

followed the Texas example by adopting some form of renewable energy zoning in an effort to identify and prioritize environmentally desirable, lower conflict sites for new generation and transmission[23].

With support from DOE, planners are also developing new informational tools to anticipate and avoid environmental and cultural conflicts. Argonne National Laboratory has undertaken an innovative mapping effort to cut through the complexity of the Eastern Connection at a system level. Argonne's tool has multiple layers of data that could help planners to identify low conflict sites for renewable energy and transmission development. The Environmental Data Task Force of the Western Electricity Coordinating Council is currently considering a plan to populate Argonne's platform with data from the west as an additional step toward creating a comparable national database which would be available to planners, project developers and the public[24].

Engaging stakeholders early, often, and throughout the transmission planning and development process remains essential to moving projects forward. Policy reforms by FERC, regional transmission organizations, utilities, and developers are providing landowners, customers, environmental advocates, and businesses with greater opportunities to provide input into the planning process. Prior to filing its request for approval with the Illinois Commerce Commission in October, 2012, Rock Island Clean Line held more than 600 meetings with landowners, public officials, community leaders, and regulators in Illinois and Iowa[25]. Transparency and engagement are resource and time consuming, but are effective means of building broad support for projects and accelerate their approval.

Optimizing operation of the transmission system delivers even greater economic, reliability and environmental benefits at minimal additional cost while simultaneously building support for essential new transmission investments.

Operating the transmission system as efficiently as possible reduces costs by making the grid more reliable and efficient. Expansions and upgrades to a smoothly operating grid are more likely to be supported by consumers, regulators, and policymakers than investments in a system perceived as wasteful or inefficient. Although losses from transmission and distribution are at historic lows, significant operational improvements remain untapped. In addition, the transition from a generation fleet dominated by steady but inflexible "baseload" power plants to one with much higher levels of variable renewable resources is spurring the development of new approaches to balancing generation and load. Grid operators today manage high levels of variable renewable resources much more easily than anyone predicted, and states and RTOs regularly shatter annual and single day records for renewables as a percentage of total generation without compromising system reliability:

- ERCOT, 3/26/2014, wind generation reached 10,296 MW, meeting almost 40 percent of electricity demand.

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[23] *Finding a Home for Renewable Energy and Transmission*, Carl Zichella and Johnathan Hladik, America's Power Plan, September, 2013.
[24] *Ibid*.
[25] "Rock Island Clean Line Files Proposed Illinois Route With Illinois Commerce Commission." Press Release, Clean Line Energy Partners, October 10, 2012.

- MISO, 11/23/2012, wind generation reached 10,012 MW, meeting 25 percent of demand across a region spanning all or part of twelve states.
- Iowa received more than 27 percent of its electricity from wind in 2013, the highest percentage ever for any state over a full year, and enough electricity to power more than 1.4 million homes.

Grid operators like Joe Gardner, Executive Director of Real-Time Operations for MISO, credit numerous factors for their success in managing high levels of variable resources without incident, notably:

- Geographic diversity. The wind blows at different times in different places across MISO's twelve state footprint – smoothing out the variation at any single location.
- Better forecasting tools make it easier to accurately predict wind turbine output.
- Transmission expansions and upgrades are being approved and constructed, giving operators greater flexibility to manage all resources, and giving consumers more choices via competition.
- Grid operators around the country and the globe are learning from each other as they successfully integrate ever larger shares of renewable energy on their systems.

Transmission is poised to become even more efficient as operators take advantage of new technologies, some of which are already widely installed. Synchrophasors monitor electrical conditions hundreds of times faster than current technologies – 30 to 120 times per second – and time-stamp every measurement to synchronize data across large regions of the high voltage transmission system. Grid operators can use this information to detect disturbances that would have been impossible to see in the past, and to take actions to address them before they lead to much more serious and costly problems, like severe congestion, voltage reductions, or widespread and potentially catastrophic losses of power, like the Northeast Blackout of 2003. Forward thinking Administration polices, notably DOE's Smart Grid Investment Grants, have dramatically increased the number of synchrophasors connected to the U.S. high voltage transmission system: from just 200 in 2009 to more than 1700 today. Grid operators are still in the very early stages of developing new practices which take full advantage of this rich new information resource these devices are providing. Although it is impossible to predict exactly how synchrophasors will change the grid, it is virtually certain that they will make it more efficient, reliable and resilient than ever.

<u>Updating market rules can remove barriers to the full utilization of the high voltage network.</u>

Physical and technological constraints are not the only obstacles preventing us from getting the most out of the high-voltage system; outdated and unfair market rules are also to blame. Transmission networks are powerful enablers of wholesale electric markets, but only where market rules allow participants to take full advantage of the physical infrastructure. Regulators and market operators (ISOs and RTOs) across the country are taking steps to update how markets operate to ensure that consumers get the most out the high voltage system in a rapidly changing environment. DOE should continue to support and encourage the full range of extremely beneficial market reforms and innovations, including:

- *Consolidating Balancing Authorities and Markets*

  SPP launched its Integrated Marketplace on March 1 of this year, a set of reforms which are expected to deliver $100 million annual benefits to consumers in the region[26][27]. The Integrated Marketplace replaces SPP's Energy Imbalance Service Market, which has been in operation since 2007 and combines SPP's 16 "legacy" grid-balancing authorities into a single consolidated SPP balancing authority. Consolidating balancing authorities and other market reforms included in the Integrated Marketplace improve grid reliability by allowing grid operators to select the most cost effective resources across the entire footprint to balance region-wide supply and demand.

- *Energy Imbalance Markets*

  In June of this year, FERC conditionally accepted California Independent System Operator Corporation's (CAISO) proposal to implement an Energy Imbalance Market (EIM) that will allow neighboring balancing authorities to participate in its real-time market for imbalance energy. The result of an extensive stakeholder process, the EIM allows participants to buy and sell five-minute real-time energy to address energy imbalances through a regional market mechanism. CAISO and PacifiCorp estimate that the EIM will generate up to $129 million in annual consumer benefits in their balancing authority areas from economic efficiencies, improved renewable integration and increased reliability[28]. The major distinction between the EIM and SPP's integrated Marketplace is that the EIMA is voluntary – CAISO will not assume operational control over the transmission facilities in the participating balancing authorities, unless a transmission voluntarily places them under CAISO's control. (SPP assumes operational control over transmission facilities across its entire footprint in its Integrated Marketplace.)

- *Dispatchable Intermittent Resource (DIR) programs*

  In 2011, FERC-approved MISO's DIR initiative which allows variable renewable generation to be treated like any other generation resource in the market and, for the first time, participate in the region's real-time energy market. Under the DIR, wind is automatically dispatched up to a forecasted limit based on market and system conditions. Wind generators now have the ability to avoid manually curtailment when transmission constraints limit generation by selling their power in the real-time regional market. This change makes more efficient use of both the transmission system and of variable renewable resources.

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[26] "SPP's Integrated Marketplace online and running smoothly," Press Release, Southwest Power Pool, March 3, 2014.

[27] SPP encompasses 15 million customers, 48,930 miles of transmission lines, and 370,000 square miles of service territory in Arkansas, Kansas, Louisiana, Mississippi, Missouri, Nebraska, New Mexico, Oklahoma, and Texas. Late next year the Western Area Power Administration's Upper Great Plains Region is expected to join SPP, adding significant new customers, grid assets, and service territory in Iowa, Minnesota, Montana, North Dakota and South Dakota.

[28] "FERC Accepts CAISO Energy Imbalance Market; PacifiCorp First Participant," Press Release, Federal Energy Regulatory Commission, June 19,2014.

High Voltage Direct Current (HVDC) transmission is a proven technology well suited to critical challenges facing the electricity sector.

Although America's high-voltage transmission network is built on alternating current (AC) technology, HVDC transmission is a proven technology well-suited to addressing two critical challenges: (1) delivering large amounts of renewable energy efficiently and reliably over long distances; and (2) increasing transfer capacity between RTOs and interconnections. Electrical losses for HVDC lines are significantly lower than for comparable high voltage AC lines, an advantage that increases with line length and voltage. HVDC lines can be sited in smaller corridors than comparable AC lines, reducing visual and environmental impacts. Grid operators can precisely control power flows on HVDC lines – something they cannot do on AC lines – allowing them to dampen power oscillations on the AC system and limit the propagation of outages and other disturbances.

A growing number of proposed HVDC links are now in various stages of development around the country which would complement the AC system. HVDC lines will not obviate the need for a robust high-voltage AC system, to the contrary, deploying, expanding, and upgrading both technologies in a coordinated fashion is likely to be the most cost-effective path to achieving national economic, environmental, and security goals.

Transmission planners should fully consider all cost effective demand side and distributed resources (e.g. energy efficiency, distributed generation, demand response, storage, and distribution system upgrades) to ensure that transmission expansions and upgrades are efficient, coordinated and supported by customers.

Like high voltage transmission, demand side and distributed clean energy resources are essential to realizing a clean energy future. The explosive innovation now under way at all levels of the electricity sector will make transmission and distribution networks more valuable – not less. Just as the internet and wireless data networks grow in importance as information resources and technologies expand their reach, so too will transmission networks become ever more important as connectors of clean, distributed, and demand side energy resources. Earlier this year, the Natural Resources Defense Council (NRDC) and the Edison Electric Institute (EEI) agreed on this point in a rare joint statement to state utility regulators[29]:

> "Innovation does not threaten the grid; collectively, technology advances are making the nation's transmission and distribution systems more important than ever as drivers of economic and environmental progress."

Transmission planners must transparently account for the contributions of distributed resources to ensure that transmission investments are necessary, coordinated, and efficient, but also to build support among customers and regulators for needed expansions and upgrades. A very recent London Economics International (LEI) report commissioned by the WIRES Group proposes a set of analytical tools and modeling techniques (a "toolkit") to help planners and stakeholders evaluate a broad range of

[29] EEI/NRDC JOINT STATEMENT TO STATE UTILITY REGULATORS, February 12, 2014

"market resource alternatives (MRAs)[30]," alongside transmission investments. In light of consumer interest in MRAs, advancements in technology, policy evolution, and the urgent need for transmission expansions and upgrades, the report identifies and takes initial steps toward addressing the challenge facing planners and stakeholders alike:

> "An understanding of what services MRAs can and cannot provide, and the benefits and challenges associated with MRAs is therefore critical for system planners, who must ultimately be able to evaluate viable MRAs and transmission projects side-by-side and select a solution that best addresses the needs of the electric power system and customers."

Distributed resources, a.k.a. MRAs, are most often complements to, not substitutes for, high voltage transmission investments. Distributed generation, microgrids, , and storage are poised to grow rapidly and play critical roles in the system – especially among users who place a high value on resiliency and robustness, e.g. military, emergency services, public safety, and acute health care.

America's inadequate high voltage transmission network is already constraining renewable energy development and making it less efficient.

We know that regions with the most installed renewable energy capacity have both strong resources and policies in place to expand and modernize high voltage transmission networks. Evidence is now emerging that insufficient transmission is driving renewable energy developers to lower quality resource locations with existing access to transmission lines. Among projects built in 2012, the average estimated quality of the wind resource at 80 meters was roughly 15% lower than for projects built in 1998–1999 – with most of the decline occurring since 2008. If transmission constraints were not driving developers toward lower resource quality sites, wind capacity factors would be increasing steadily, rather than stagnating as they have since 2006[31]. Given the enormous amount of renewable energy the country needs to develop to meet science-based carbon targets, and the vast supply of untapped high quality renewable resources in remote regions, transmission investments appear even more urgent.

Despite recent policy reforms, the most critical interstate and interregional transmission investments are still proceeding too slowly to meet national economic and environmental goals.

Despite policy and regulatory reforms, improvements in planning, and a growing body of evidence showing the enormous benefits of high voltage transmission investments, the most urgently needed interstate and interregional expansions and upgrades to America's high voltage network face daunting and as yet unresolved challenges. It is increasingly clear that regional and utility planners are unlikely to overcome these obstacles without more active federal involvement, including but not limited to analytic support, coordination assistance, the vigorous and thoughtful application of existing authorities, and a prompt review of whether new powers may be needed.

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[30] LEI proposes MRAs as a substitute term for "non-transmission alternatives" defined by FERC in Order 1000. As defined by LEI, MRAs include distributed generation ("DG"), energy efficiency ("EE"), demand response ("DR"), utility-scale generation, and storage.

[31] Ryan Wiser and Mark Bollinger, *2013 Wind Technologies Market Report*, Lawrence Berkeley National Laboratory, U.S. Department of Energy, August, 2014.

Specific issues are now emerging which illustrate why DOE and the Administration must continue to support and promote urgently needed transmission expansion and upgrades:

- In the nearly three years since their Board of Directors approved the MVP portfolio in December 2011, MISO has not made significant progress planning the next set of transmission lines, which will be needed to replace the growing amount of generating capacity the region expects to lose as coal plants retire in response to new EPA regulations on carbon emissions. MISO's estimate of anticipated coal plant retirements has more than doubled in recent years, from 12.6 GW to 26.6 GW.
- Interregional coordination required under FERC Order 1000 has so far failed to advance any significant transmission solutions which cross more than one planning region. Transmission lines across interregional "seams" (i.e. boundaries) have the potential to deliver enormous economic and environmental value by making markets more competitive and efficient and enabling renewable energy development and delivery. For example, MISO's Interregional Planning Stakeholder Advisory Committee (IPSAC), is still seeking agreement with its counterparts in the neighboring SPP and PJM regions on criteria and metrics to use to screen for worthy transmission projects.

Conclusion and Recommendations:

ACEG and its supporters recognize that the energy infrastructure decisions we make as a nation over the next few decades will shape the economic, national security, and environmental futures of Americans for the rest of this century and beyond. We live in the age of electricity, and no single element of our energy infrastructure will have a greater impact on that future than the network which makes modern life possible: the electric transmission and distribution system. If we take aggressive steps now to modernize and expand it, we will place ourselves in a position to achieve our national goals and to lead the world in meeting pressing global economic, environmental and security challenges. With that in mind, we urge the administration to be bold, and to embrace the following recommendations in their report:

- DOE should develop new federal legislation, modeled on successful state and regional approaches like the Texas CREZ, MISO MVP, and California RETI, to strengthen and expand federal authority to plan, allocate costs of, and site new interstate and interregional high voltage transmission lines capable of developing, integrating, and balancing enough zero carbon renewable energy to reduce electricity sector carbon emissions by 80 percent or more by 2050 while securing and expanding universal access to affordable and reliable electricity in every part of the country.
- DOE should, in cooperation with interested stakeholders, develop a comprehensive, detailed, and analytically robust vision of a national high voltage transmission network capable of supporting very high levels of renewable energy generation (i.e. 80 percent or more, as NREL and others have studied.) The national vision should identify the highest priority inter-regional lines to link balancing areas, RTOs, and interconnections, and lines which will speed the development of large, high quality renewable resources in remote areas, i.e. "renewable energy zones."

- DOE should invest significant new technical and communications resources to improve analysis of the benefits and costs of high voltage transmission investments and to make the results of those analyses accessible to broad non-technical audiences including state regulators, consumers, businesses, and on-profit advocacy organizations.
- DOE should promote, provide technical support for, and analyze the benefits of harmonized grid operations and increased competition in electricity markets.
- DOE should utilize the resources of the National Laboratories to assess how new technologies can make high voltage transmission more efficient, robust, and resilient, and facilitate its siting by reducing land-use and visual impacts, avoiding sensitive areas, and making use of existing development corridors.
- The QER should highlight the need for state and federal regulators to set rates of return on equity (ROE) for transmission projects at levels high enough to maintain strong capital flows for several decades.
- DOE should utilize existing authorities under Section 1222 of the Energy Policy Act of 2005 to participate in public-private partnerships that develop, construct, operate, and maintain new interstate transmission lines to meet anticipated future electric transmission needs, enable the development of new renewable generation capacity, and provide customers with greater access to low-cost renewable energy.
- DOE should promote, provide technical support for, and analyze the potential reliability, cost saving and pollution reduction benefits of demand-side resources (e.g., energy efficiency, demand response, distributed generation, energy storage) in a manner that facilitates their comparable treatment in local and transmission planning.

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