A Renewable America

TRANSMISSION UPGRADES & EXPANSION: KEYS TO MEETING LARGE CUSTOMER DEMAND FOR RENEWABLE ENERGY



Prepared by David Gardiner and Associates for the Wind Energy Foundation

January 2018

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A project of the Wind Energy Foundation

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I. INTRODUCTION

This report examines the opportunity to meet large customer demand for renewable energy through transmission upgrades and expansion. The need for this report is driven by two key emerging trends: (1) demand from large corporations is growing rapidly, as many are choosing renewable power to meet their existing needs as well as supply new demand; and (2) renewable energy is more affordable than ever, but customers' access to this affordable energy is constrained by inadequate transmission planning.

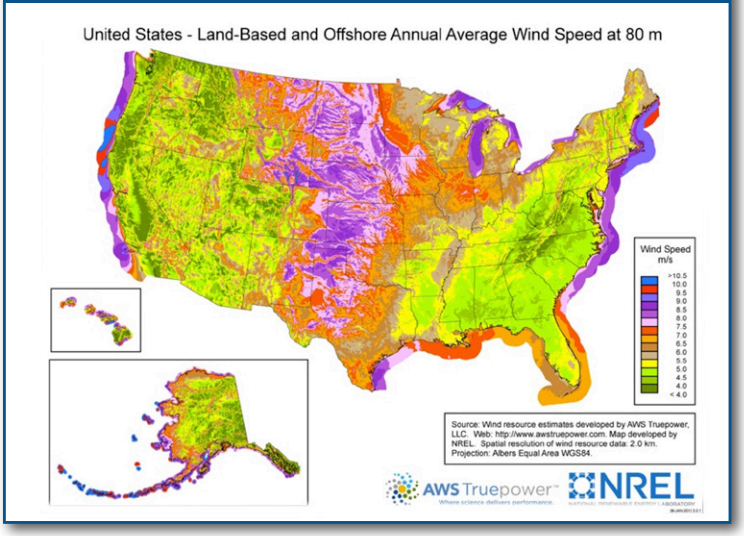
The report examines opportunities across four key Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs): the Electric Reliability Council of Texas (ERCOT), the Midcontinent Independent System Operator (MISO), the PJM Interconnection (PJM), and the Southwest Power Pool (SPP). These four RTOs are of particular interest because they span geographic regions with high on-shore wind resources (especially ERCOT and SPP), as illustrated in Figure 2.[1] The Wind Energy Foundation commissioned this report on behalf of its A Renewable America campaign.

Figure 1. Map of Regional Transmission Organizations (RTO)/ Independent System Operators (ISO)



Source: U.S. Federal Energy Regulatory Commission (FERC), https://www.ferc.gov/industries/electric/indus-act/rto.asp

Figure 2. Land-Based and Offshore Annual Average Wind Speed at 80 m



Source: National Renewable Energy Laboratory, http://bit.ly/2zSUGFv

II. EXECUTIVE SUMMARY

This report examines the need to expand and upgrade U.S. transmission lines to meet the significant renewable energy demand of large non-utility customers, especially from Fortune 500 companies.

Investment in transmission infrastructure is essential to support not only significant additions of renewable generation to meet corporate and other demand, but also for the longer-term electrification of transport, heating, and cooling. We found that: (1) renewable energy commitments from large corporations are growing rapidly and will lead to significant renewable energy procurement through 2025; (2) most of the best renewable energy resources are in a 15-state central U.S. region, while load growth is highest outside the region; (3) expanded and upgraded transmission is needed to unlock new low-cost renewable energy for corporate and other consumers; and (4) transmission planners should account for corporate demand.

KEY FINDINGS:

Corporate commitments to procure renewable energy are growing rapidly and are projected to continue to do so.

- Renewable energy procurement from large institutional buyers, including many Fortune 500 companies, has increased considerably in recent years and is one of the most dramatic recent changes in electricity markets.[2] Since 2013, U.S. corporations have signed nearly 9 gigawatts (GW) of long-term wind and solar power contracts (equal to over 16 conventional power plants and enough electricity to power over 7.5 million homes).[3]
- The Renewable Energy Buyers Alliance (REBA), representing more than 100 U.S. corporate buyers, set a goal to deploy 60 GW of new renewable energy capacity in the U.S. by 2025 —equal to 110 conventional power plants and enough electricity to power nearly 50 million homes.[4] Considering the 9 GW of renewable energy already procured by corporate purchasers since 2013, there is at least 51 GW remaining in this goal.
- These companies have a variety of reasons for increasing their demand for renewable energy, such as lower costs, price risk reductions, and corporate environmental initiatives.

Transmission expansion and upgrades are needed to spur enough renewable energy development to meet this growing demand, and can provide other benefits.

- The strongest and often lowest-cost renewable energy resources are located in the central U.S. region, 15 states between the Rockies and the Mississippi River: Arkansas, Colorado, Iowa, Kansas, Louisiana, Minnesota, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming.
- This region accounts for 88 percent of the country's wind technical potential and 56 percent of the country's utility-scale solar photovoltaic technical potential, yet is home to only 30 percent of projected 2050 electricity demand (see Section IV). This finding suggests that future transmission is needed to export this electricity from this high-production region to the growing demand outside of this region.
- Transmission upgrades and expansion provide large non-utility customers access to low-cost renewable energy through power purchase agreements (PPAs).
- Increasing the supply of renewable energy through transmission can deliver cost savings, grid reliability benefits, and greenhouse gas (GHG) emissions reductions to all customers.
- Upgrading and expanding the existing transmission network would also relieve congestion problems and could lower costs for non-PPA consumers.[5]

Transmission planning fails to account for the rapid increase in corporate and other institutional demand and does not focus adequately on the need to transmit renewable electricity from the central U.S. region to the rest of the country or on remote high-quality renewable resource areas within each region.

- Current transmission planning accounts for predicted customer demand, known power plants and their locations, grid reliability issues requirements, and public policy requirements, such as state and federal environmental and clean energy standards.
- Transmission planners may, in rare instances, account for voluntary goals, such as statements by Governors, but do not account for the growing voluntary demand from large corporate purchasers.
- Transmission planning is performed in fragmented sub-regions of the country, mainly through the Regional Transmission Organizations. Large amounts of potential wind and solar energy are lost every day in America's heartland due to the lack of interregional transmission planning to deliver them to markets in the East and West. There are particular challenges associated with transferring electricity from the Eastern Interconnection to the Western Interconnection, which can be done today through limited direct-current interconnections, but future improvements could enable a unified national power grid.

KEY RECOMMENDATIONS:

Corporate buyers and other large institutional customers should:

- Encourage transmission planners and state Public Service Commissions to increase access to affordable, renewable energy by approving upgrades and expansion to transmission lines;
- Participate in regional and inter-regional transmission planning conversations to ensure future transmission infrastructure meets customer demand for renewable energy; and
- Urge FERC to continue work to improve the interregional planning processes consistent with Order 1000.

Operators of Regional Transmission Organizations and others involved in transmission planning should:

- Incorporate voluntary, large customer demand in transmission planning.
- Strengthen planning across RTOs and other regional planning authorities to ensure efficient interregional transmission.







III. CORPORATE DEMAND FOR RENEWABLE ENERGY IS GROWING

Over the past several years, corporate demand for renewable energy has risen sharply as many companies have made public commitments to power their operations with renewable energy or to reduce their greenhouse gas emissions. Perhaps most notably, in May 2016, a coalition representing over 100 corporate energy buyers (the "Renewable Energy Buyers Alliance" or "REBA") announced a goal to purchase 60 gigawatts (GW) of new renewable energy capacity in the U.S. by 2025. REBA collaborates with RE100, a group of corporate purchasers committed to source 100 percent of their power from electricity, which includes notable members such as Anheuser-Busch InBev, BMW, General Motors (GM), Johnson & Johnson, and Procter & Gamble (P&G).[6] This 60 GW goal is used as the basis for the analysis in Section VIII.

Since 2013, corporate buyers have procured 9 GW of renewable energy through power purchase agreements (PPAs).[7] Even though PPAs have been the predominant procurement mechanism for much of the renewable energy already contracted by corporates, looking forward, a mix of both PPAs and utility products will likely be necessary to achieve the ambitious 60 GW goal. Utilities around the U.S. are currently developing tools, such as green tariffs, that allow corporates to purchase renewable energy directly through their utility. For example, recently in Kansas, Westar Energy and Kansas Gas and Electric Co. have proposed a new renewable energy tariff aimed at commercial and industrial customers that would provide wind capacity less expensively than the utilities' current offerings.[8]

Other groups and recent surveys have similarly tracked corporate demand for renewable energy using different metrics, finding that:

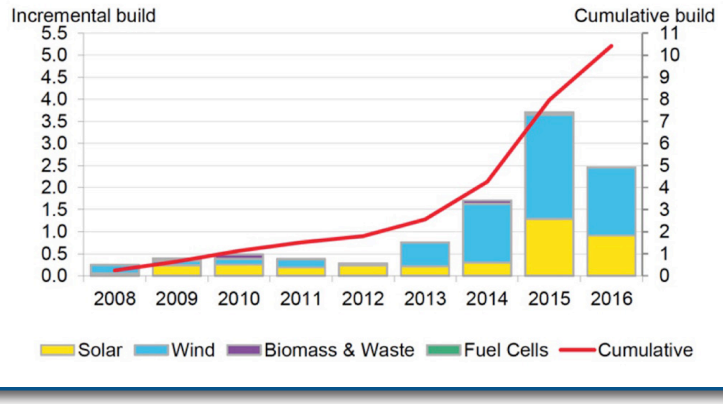
- Forty-eight percent of Fortune 500, and 63 percent of the Fortune 100, have set targets to reduce GHG emissions, improve energy efficiency, and/or increase renewable energy.[9] Fortune 500 clean energy targets have increased 5 percent since 2014.[10]
- Among 160 of the largest global manufacturers with a U.S. footprint: (1) 40 companies (25 percent) have established a renewable energy target and 18 companies (11 percent) have established a 100 percent renewable energy target; and (2) 132 manufacturers (83 percent) have established goals to curb their GHG emissions—a precursor to acquiring renewable energy, according to a recent study by David Gardiner and Associates.[11] The 40 companies with renewable energy targets account for 659 factories in the U.S.
- Seventy companies support the Corporate Renewable Energy Buyers' Principles, aimed at spurring utilities and regulators to increase corporate customer access to renewable energy.

Of a recent survey of 153 large corporate buyers (public and private), 128 (or 84 percent) are actively pursuing or considering purchasing renewable energy over the next five to ten years.[12]

These commitments demonstrate that large customers and their ambitious climate and energy targets will help sustain demand for renewable energy and act as market drivers throughout the 2020s. Further, potential voluntary demand from corporates is as much as three time greater than projected RPS-driven demand, as discussed in Section VIII.

As a result of these commitments, corporate renewable energy procurement has increased significantly in the last decade. Between 2008 and 2016, U.S. corporations signed more than 10 GW of long-term wind and solar power contracts—equal to 18 conventional power plants and enough electricity to power over 8 million homes (Figure 3).[13] As mentioned, the bulk of that contracted renewable capacity—9 GW—has been acquired since 2013. Indeed, these significant purchases from non-utility customers are one of the most disruptive trends in the electricity market. In fact, corporate and other non-utility customers (including the U.S. Army and universities), accounted for 52 percent of all wind capacity contracted through PPAs signed in 2015, and 39 percent in 2016.[14]

Figure 3. Renewable capacity contracted by corporations by technology, 2008-2016 (MW)



Source: Bloomberg Finance 2017 Sustainable Energy in America Factbook

Large companies are leading the way in non-utility renewable energy purchases.

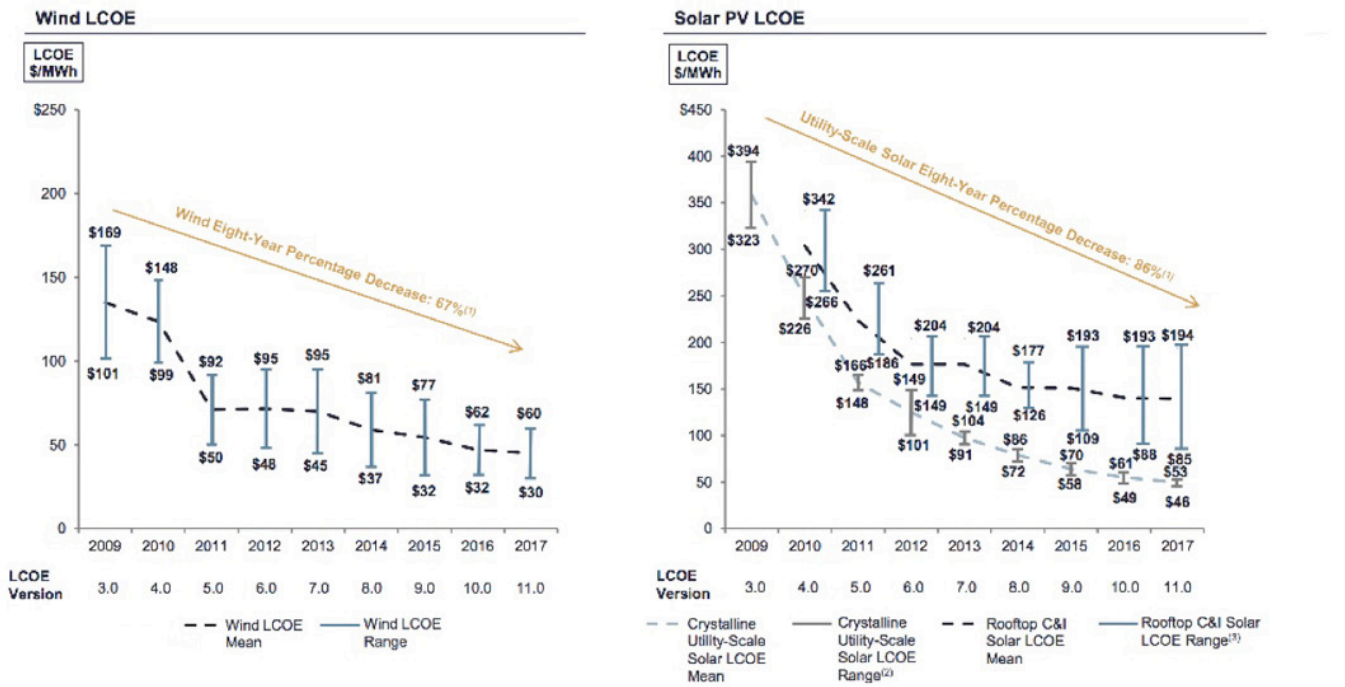
- In 2016, **Amazon** signed PPAs for 650 MW of clean energy; Amazon's 228 MW PPA with Lincoln Clean Energy for the Amazon Wind Farm Texas was the largest signed in 2016 and brings Amazon's cumulative U.S. deals to 1.2 GW.[15]
- In September 2017, **GM** announced a 200 MW wind purchase which will power all of the company's Ohio and Indiana manufacturing facilities.[16] Once the turbines come online by the end of 2018, renewable energy will power 20 percent of GM's global electricity use.
- Companies like **Google** (1.9 GW signed in total in 2016), **Microsoft** (500 MW signed in total in 2016) and **Walmart** (500 MW signed in total in 2016), **Kimberly-Clark** (245 MW PPA signed in 2017), and **Anheuser Busch InBev** (152.5 MW PPA signed in 2017) also continue to lead in this space.[17,18,19]

Companies are investing in renewable energy primarily because it is increasingly the lowest cost option, as wind and solar are often the cheapest sources of new generation. Today's wind costs are one-third what they were in 2009, falling 67 percent, from $140/MWh to a range of $30-60/MWh in just eight years.[20] The cost of utility-scale solar has declined even more dramatically, falling 86 percent since 2009 to today's range of $46-53/MWh (Figure 4).[21] Note that the charts in Figure 4 are based on levelized cost of energy (capital costs plus operating costs per MWh) and do not reflect the full advantage of renewable energy in the bulk power markets, where pricing is driven exclusively by variable operating costs, which are effectively zero for renewable energy. Therefore, renewable energy is even more cost-competitive than is reflected here.

Competitive pricing, the ability to lock in contract prices for 20 years or longer, and other key drivers have stimulated corporate demand for wind and solar. Companies are also motivated to invest in renewable energy to:

- Stabilize energy pricing and reduce risks of long-term price volatility;
- Address demand from investors and customers;
- Reduce risks of climate change to operations and supply chains;
- Minimize carbon emissions and other air pollutants from their energy usage;
- Demonstrate corporate leadership, innovation, competitive first-mover advantage, and to keep up with growing trends from competitors and peers.

Figure 4. Unsubsidized Levelized Cost of Energy—Wind & Solar PV (Historical)

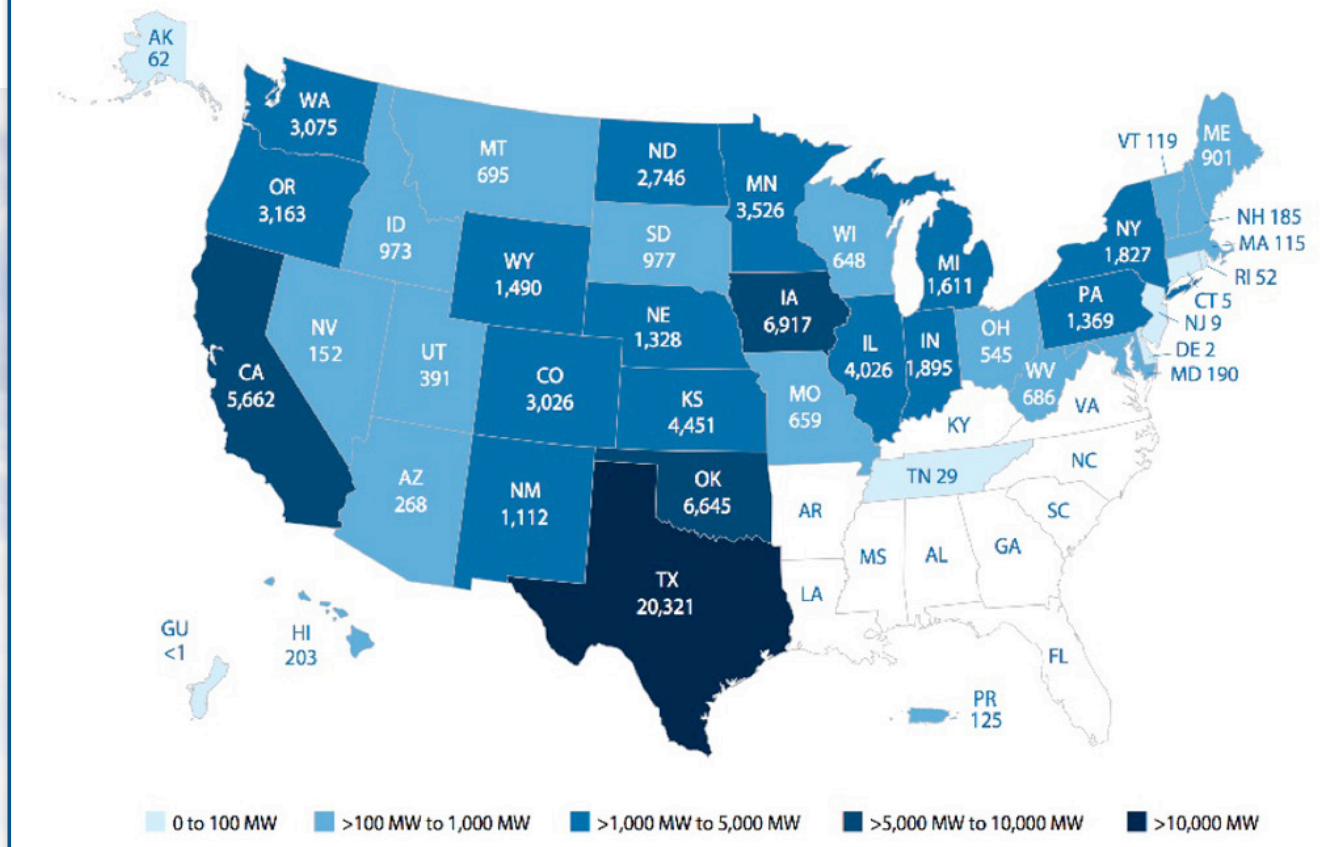


Source: Lazard, 2017, Levelized Cost of Energy Analysis—Version 11.0

IV. THE CENTRAL U.S. LEADS THE NATION IN RENEWABLE ENERGY PRODUCTION AND POTENTIAL

The majority of renewable energy production is occurring, in the central U.S. region between the Rockies and the Mississippi River—in Montana, Wyoming, Colorado, New Mexico, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Minnesota, Iowa, Missouri, Arkansas, and Louisiana.[22] Currently, there is 53,893 MW of installed wind capacity in this region, about 66 percent of all installations, as shown in Figure 5. Only 14,214 MW were installed in states east of those states to date (17 percent of total), and 13,949 MW in to the west (17 percent of total).

Figure 5. U.S. Installed Wind Power Capacity, by State (MW)



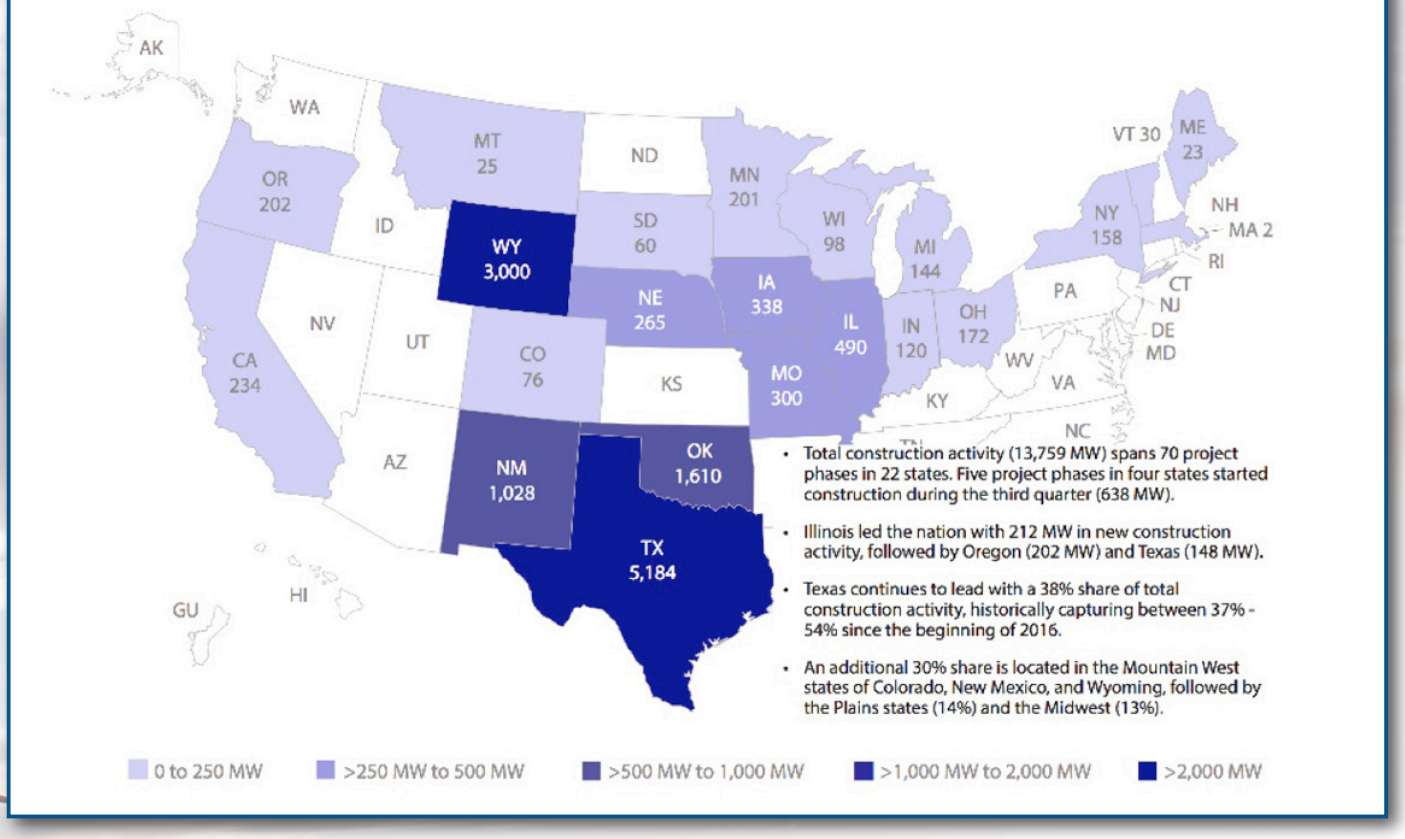
Source: AWEA, U.S. Wind Industry Fourth Quarter 2016 Market Report

This region also includes the five states producing the largest percentage of their power from wind turbines – Iowa, Kansas, South Dakota, Oklahoma, and North Dakota – as well as Texas, the largest wind power producer in absolute terms.[23]

Projected new wind capacity is and will be located in this region. Most wind capacity currently under construction is concentrated in Texas, New Mexico, Oklahoma, and Wyoming (Figure 6). A total of 10,822 MW of wind capacity is under construction in those four states. Texas alone is responsible for 38 percent of total construction activity, as indicated in Figure 6.

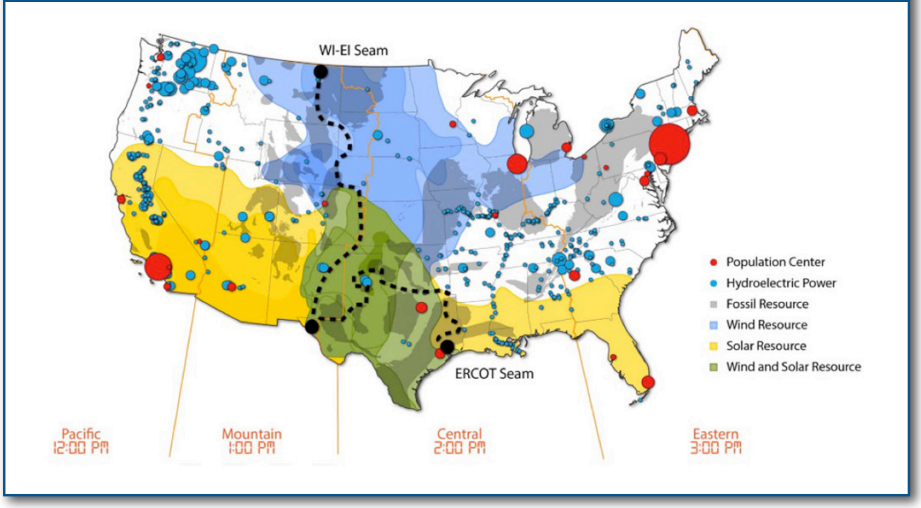
Moreover, the greatest future potential for both wind and solar resources is also located in this region and across the Southern U.S. (Figure 7). This region accounts for 88 percent of the country's wind technical potential and 56 percent of the country utility-scale solar PV technical potential (Table 1). However, the majority of future load growth is located in areas outside this region. Thus, as discussed later in this report, these regions should develop additional transmission lines to meet that demand, as well as the growing corporate demand.

Figure 6. U.S. Wind Capacity Under Construction (MW)



Source: AWEA, U.S. Wind Industry Third Quarter 2017 Market Report

Figure 7. Locations of Energy Resources and Population Centers



Source: NREL, 2017, Interconnections Seam Study

The "central U.S. region" contains most of the technical potential for wind and solar development, but low projected load growth. These 15 renewable energy-rich states comprise approximately 88 percent of total technical potential for onshore wind power and 56 percent of total technical potential for utility-scale solar photovoltaics (Table 1). However, they only account for 30 percent of future electricity demand in 2050, according to projections from the U.S. Energy Information Administration. The remainder of electricity demand in 2050—70 percent—is projected to be from states outside of this region.

A fully integrated national transmission grid is technically feasible. It would require joining the three existing transmission interconnections – Eastern, Western, and ERCOT – either by strengthened direct-current interties or by synchronizing their alternating currents and providing high-voltage interconnections between major systems. In the future, it may well be possible for wind-generated energy in the Midwest and Plains states to help meet the fast-ramping demand peak in California illustrated by the celebrated "duck curve," even as solar energy generated in the desert Southwest has earlier in the same day helped meet early-evening peak demands on the East Coast.

As mentioned, the potential level of corporate demand for renewables may reach up to 60 GW—demand that is not typically accounted for in transmission planners' load growth projections, as further described in Section IX. And these corporations would be interested in purchasing cost-competitive power from renewable projects in the central U.S. region. These findings underscore the importance of expanding and upgrading transmission in the areas of best technical potential to deliver the lowest-cost energy resources to the grid. It is important to note that in-state transmission may also be needed to bring energy to the grid, depending on the location of the generating facilities.

Table 1. Comparison of Total Technical Potential for Onshore Wind and Utility-Scale Solar PV by Region[24]

Region	Total Technical Potential for Onshore Wind Power[a] (%)	Total Technical Potential for Utility-Scale Solar PV[b] (%)	Projected Electricity Sales, 2050 (billion kWh)[c]	Projected Electricity Sales, 2050 (%)
Central U.S. Region	88%	56%	1,341	30%
Other	12%	44%	3,133	70%

[a] *AWEA, U.S. Wind Industry Fourth Quarter 2016 Market Report*
[b] *NREL,* https://www.nrel.gov/docs/fy12osti/51946.pdf
[c] *EIA,* https://www.eia.gov/outlooks/aeo/tables_ref.php

Further, in some areas, wind energy curtailment continues to occur, in part, as a result of transmission congestion or a lack of transmission access. For example, on April 24, 2017, when SPP set the North American record for producing the most wind at 54.47 percent or approximately 11,300 MW of wind output, it still curtailed 789 MW of wind.[25] This finding suggests transmission expansion either within the region or connecting to neighboring regions is needed to provide more customers with access to inexpensive renewable energy.



V. POWER PURCHASE AGREEMENTS, WHICH DEPEND ON TRANSMISSION, ARE ENABLING CORPORATE PURCHASERS TO PROCURE RENEWABLE ENERGY

A power purchase agreement (PPA) is a contract between two parties, one which generates electricity (the seller) and one which is looking to purchase electricity (the buyer). The PPA defines the commercial terms for the sale of electricity between the two parties, such as the schedule for delivery of electricity and payment terms. Corporate energy buyers may choose either a physical or virtual PPA based on a combination of factors, including: access to retail electricity choice; ability to act as wholesale energy customers; relative location of energy demand to economic wind projects; timing of retail energy procurement contracts; and expected lifetime of facilities with energy demand.[26] In either case, as explained below, these transactions require delivery of power through high-voltage transmission lines.

In a physical PPA, power is "physically" delivered to the buyer, and the renewable energy project and the buyer must be located in the same grid region. Therefore, *the need for transmission is implicit in a physical PPA; without adequate transmission to allow for the development of renewable project, physical PPAs would not happen.*

Physical PPAs are limited to buyers that can sign PPAs as either retail or wholesale market participants.[27] As a wholesale electricity customer, a company that signs a physical PPA buys the renewable energy produced at wholesale prices—not as a traditional retail customer.[28]

One way that a company can act as a wholesale electricity customer is by becoming a wholesale power marketer.[29] Wholesale power marketers have the ability to sign physical PPAs and buy energy at wholesale market prices, subsequently reselling the energy to wholesale customers and retaining the associated renewable energy credits (RECs).[30]

A virtual PPA (VPPA), also known as a synthetic or financial PPA, is a financial arrangement between a renewable energy project and a buyer, with the buyer owning the project's RECs. Under a VPPA, a buyer enters into a contract to pay a renewable energy project owner an agreed price for energy generated, and then the project owner sells the generated power into the local wholesale market on a merchant basis. The project owner pays the company if the electricity is sold into the market above the agreed contract price, and the company pays the project owner the difference if the electricity falls below the agreed price.[31] Thus, a VPPA acts as a price hedge, as the buyer is insuring itself from future price increases. Of course, if wholesale prices fall, the buyer will not receive gains.

Since the renewable energy project and the buyer do not need to be in the same grid region, virtual PPAs are appealing to buyers located in states that do not permit direct retail access, as well as for buyers where it's too costly to act as wholesale market participants. However, *because deals can only be struck when a developer can get their product to market via transmission infrastructure, VPPAs are still only possible with transmission.*

A recent study of corporate wind PPAs of at least 20 MW in size signed through the third quarter of 2016, found that companies with the highest levels of wind energy procurement have tended to sign physical PPAs.[32] On a capacity basis, about 52 percent of the wind power contracted through corporate PPAs to date is through physical PPAs, while the remaining 48 percent is contracted through virtual PPAs.[33] However, the overall trend among corporates is moving toward VPPAs. Corporate customers signing virtual PPAs currently outpace those signing physical PPAs by a ratio of nearly 4:1.[34] Although wind energy is the preferred PPA technology for corporates currently, many companies are entering into solar PPA contracts as well, such as Apple, which has contracted 130 MW of solar through a PPA with First Solar.[35]

VPPAs are particularly advantageous in situations where the customer's energy demand is split into many small and separate locations or when the customer's energy demand is located in a state where renewables are not available, either because of a lack of local supply or where the electricity market makes customer procurement difficult or impossible (i.e., where PPAs are not allowed).[36] However, companies also occasionally enter into VPPAs from within the same grid region, as the costs associated with becoming a wholesale market participant may make PPAs less attractive.[37]





VI. PLANNING AND DEVELOPING TRANSMISSION REQUIRES FEDERAL, STATE, AND LOCAL COORDINATION

Building a transmission line can require the involvement of a number of several different parties, including state, regional and federal authorities, Planning Coordinators, utilities, and transmission developers. The role played by each of the actors in this process is detailed in the following sections.

A key barrier to bringing more renewable energy on line is the absence of transmission planning across RTOs and other regional planning authorities. The U.S. has three large interconnections, but transmission planning is typically performed at the RTO level. To ensure efficient interregional transmission, FERC should consider removing barriers to consumer access to low-cost resources by facilitating interregional planning on a large scale. This policy recommendation has also been endorsed by groups such as Americans for a Clean Energy Grid—a diverse coalition of stakeholders working to enhance effective regional transmission development.[38]

State Authorities

Each state holds the primary regulatory responsibility for siting transmission lines within their borders and has its own process for granting permission to build power lines. State siting authorities must consider many factors in approving transmission lines, including the overall need for a new line, environmental impacts, property rights, and cost. Once a state gives siting approval, the transmission developer is subsequently allowed to build the transmission line and, if necessary, use the power of eminent domain to do so.

A combination of state and local government agencies oversees the siting approval process in each state. There is no universal approach for how states approve the siting of new transmission lines. Several states, for example, combine siting approval under a single agency, such as a Public Utilities Commission (PUC). Other states have a dedicated siting authority that approves transmission projects.

Although state siting and permitting processes vary by state, there are some common processes. Transmission developers submit an application to the state that includes an analysis of the need for the new line (e.g., to ensure grid reliability or connect new generation), cost estimates, and at least one proposed route. The PUC or siting authority then holds hearings—usually held in the impacted communities—in order to determine the exact route of the line, address landowner and community concerns, and discuss alternatives to the proposed route. Most states combine the need and siting approvals into one decision from the PUC or siting authority. A key factor is the underlying state law that state regulatory commissions must abide by in their decisions. In some cases, utility regulation is embodied in state constitutions. In a number of instances, multi-state or regional transmission projects have been hindered by state law requirements in a transit state prohibiting regulators from approving a project that does not bring commensurate benefits to customers in that state.

Federal Authorities

The Federal Energy Regulatory Commission (FERC) is an independent regulatory agency which regulates the interstate transmission of electricity, natural gas, and oil. FERC has broad authority to set policy for transmission planning. In 2011, FERC issued an important ruling, Order 1000, which places a series of requirements on transmission planners, including requiring transmission providers to participate in a regional transmission planning and cost allocation process which takes public policy drivers into account.[39]

Specifically, Order 1000 establishes several requirements for transmission planning, including:

- Each public utility transmission provider must participate in a regional transmission planning process that satisfies the outlined transmission planning principles and produces a regional transmission plan.
- Local and regional transmission planning processes must consider transmission needs driven by public policy requirements established by state or federal laws or regulations. Each public utility transmission provider must establish procedures to identify transmission needs driven by public policy requirements and evaluate proposed solutions to those transmission needs.
- Public utility transmission providers in each pair of neighboring transmission planning regions must coordinate to determine if there are more efficient or cost-effective solutions to their mutual transmission needs.[40]

Planning Coordinators

Planning Coordinators include RTOs, government power authorities, and electric utilities that have the responsibility of coordinating, facilitating, integrating, and evaluating transmission facilities. There are approximately 80 Planning Coordinators across the U.S. (created by the North American Electric Reliability Corporation, or NERC), seven of which are U.S. Independent System Operators (ISOs) or Regional Transmission Organizations (RTOs).

Voluntary RTOs and ISOs have formed in many regions of the U.S., including California (CAISO), Southwest (SPP), Midwest (MISO), Mid-Atlantic (PJM), New York (NYISO), New England (ISO-NE), and Texas (ERCOT). RTOs do not own transmission facilities. Instead, they plan and operate the transmission system in accordance with NERC and regional reliability criteria on behalf of their member transmission owners, ensure access to the transmission system, and manage and plan for the reliability of the transmission system.[41]

A major role of RTOs is to perform transmission planning to ensure that transmission will be reliable as demand grows and generating plants are added or retired throughout the RTO footprint. RTOs typically operate regional wholesale energy markets, in which generators offer to provide energy and the lowest cost offers are accepted as long as the transmission system can reliably deliver the power. In these markets, energy prices on the transmission system will vary whenever there is congestion on the transmission system and low-cost power plants in one region cannot fully reach the demand in another. The resulting higher energy prices within congested regions provide an economic signal for new generating plants to be located in the high-priced area, or for additional transmission to be constructed to alleviate the congestion.

Each Planning Coordinator assesses the reliability of its assigned region and coordinates planning with adjoining regions. They evaluate, develop, document, and report on expansion plans for each individual transmission planning area within their regional boundaries. The Planning Coordinator must also assess whether the integrated transmission plan meets reliability needs, and, if not, provide alternative solutions.

Utilities

Historically, because electricity production and distribution has focused on delivering electricity within a state or service territory, electric utilities have developed and owned most transmission lines. The utility is responsible for obtaining permission to build the new line from the appropriate state and local authorities, and for providing a demonstration of need and the appropriateness of the proposed route, usually through the analysis and recommendations included in the RTO or ISO in which the utility operates and/or through an integrated resource planning (IRP) process.

Once approved, the utility must raise the funds to construct the line, generally through a combination of internal cash flow and the issuance of bonds, and engage and oversee contractors to design and build the line. The utilities, who typically operate under cost-of-service rates, have been able to put the costs of transmission development into their rate base and earn a rate of return on it, as approved by state Public Utility Commissions—a ratepayer-funded model. The utility will work closely with the Planning Coordinator to integrate its local transmission planning process with the regional process. This utility-based model for developing transmission projects has been less popular for long distance transmission lines, which Public Utility Commissions may not allow into the utility rate base.

Merchant Transmission Developers

Merchant transmission providers (including third-party developers) are private companies that finance and own transmission facilities independent of generation developers or customer-serving utilities. Merchant transmission projects have been largely comprised of long-distance or submarine High Voltage Direct Current (HVDC) lines. With few utilities building long-distance transmission projects, merchant transmission developers have stepped into the breach and proposed many of the long-distance transmission projects.

Unlike utility projects, merchant transmission providers must recoup their costs through reservation charges paid by generators and/or offtakers—a voluntary participant-funded model, rather than a ratepayer-funded model. The costs of constructing proposed transmission facilities of merchant transmission projects are recovered through negotiated rates instead of the cost-based rates used by utilities. Like utility projects, inter-state merchant transmission projects must obtain state siting approval (and in some cases federal approval), although in some states the regulatory agencies involved may differ for merchant lines and utilities. For example, in Kentucky there is a separate state siting board for merchant projects.

Since merchant lines are not asking for ratepayer support, they are not part of the RTO transmission planning processes. However, they can be accounted for, like generation additions and retirements, in forecasting.

VII. DC AND AC TRANSMISSION LINES: TECHNOLOGIES AND PRIMARY BUSINESS MODELS

Historically, the transfer of electricity between regions of the U.S. has been through high voltage alternating current (AC) transmission lines. In an AC line, both the voltage and the current move in a wave-like pattern along the lines and are continually changing direction. The voltage and current on a direct current (DC) transmission line, however, do not change direction as energy is transmitted.

The major advantage to DC transmission lines is their efficiency. DC power flows steadily through the wires without changing direction multiple times per second. Even though AC power is the primary power system in the U.S., DC transmission has the ability to move large amounts of power over long distances, lowering energy losses and using less land to do so, as DC transmission lines require narrower right-of-way footprints than AC lines. As such, DC transmission technology offers many benefits over long distances. AC transmission, however, gives broader network ability and grid flexibility.

Utilizing DC transmission to carry large amounts of renewables over long distances is energy and cost efficient. This can help to lower the delivered cost of energy and to enable renewable energy to compete against other power sources. DC transmission can also enhance system stability by giving the grid operator complete control over power flow on the DC line.

Typically, merchant lines utilize DC transmission technology, but not always. The merchant model is better suited than the utility model for long-distance DC lines that span multiple states, since utilities and RTOs would have to demonstrate benefits to ratepayers in order to gain project approval and proceed with cost recovery.



CORPORATE PURCHASERS & OTHER STAKEHOLDERS ARE CALLING FOR TRANSMISSION EXPANSION

For a variety of reasons, large corporate buyers of renewable energy, policymakers, utilities, TOs and ISOs have begun to speak out publicly about the importance of expanding transmission to meet their demand for renewable energy at good prices.

"We believe that the ability to access cost-effective renewable energy from a variety of sources in TVA territory will strengthen the region's business environment and further the economic and sustainability objectives of customers like us."

GENERAL MILLS, GM, IKEA, INGERSOLL RAND, KELLOGG'S, TECHNET, AND UNILEVER

on the Plains and Eastern Clean Line Transmission Line, which would bring wind power from Oklahoma to consumers in the Southeastern and Mid-Atlantic U.S.

"The Grain Belt Express Clean Line is an opportunity to provide our companies with a link to low-cost renewable energy at a scale that is meaningful… We believe that the ability to access cost-effective renewable energy from a variety of sources in Missouri will only strengthen the region's business environment and further the economic and sustainability objectives of customers like us."

GENERAL MILLS, GM, KELLOGG'S, NESTLE, P&G, TARGET, UNILEVER

on the Grain Belt Express Clean Line Transmission Line, which would bring wind power from Kansas to consumers in Missouri, Illinois, and surrounding states.

"This project benefited the region in more ways than we initially thought it would. At first the main benefit was increasing supplies into Wisconsin, but then the reliability dimension really started to come into play."

BRAD OACHS
Vice president, Power Delivery and Transmission, Minnesota Power

"Significant wind energy has come online in the Midwest since this project was energized. Without this line in place, much of this renewable electricity would have been trapped behind the congestion point at the Minnesota-Wisconsin border. With Arrowhead-Weston in place, we can move more wind and hydro power across the Midwest."

DEDE SUBAKTI
Manager, Regional Operations Engineers, MISO

"We should be saying, 'solar, wind, transmission,' in the same breath. Transmission needs to be on equal footing and of the same stature as renewable forms of energy because we won't reach our goals without it."

WISCONSIN STATE REPRESENTATIVE PHIL MONTGOMERY
Current member and former chairman, Assembly Energy and Utilities Committee

"GM's ability to access renewable energy is key to our decisions about where to expand new facilities. It's essential that transmission planners take the growing corporate demand for renewables into account in the planning process. Expanding and upgrading transmission is critical to help GM access low-cost renewable energy and meet our commitments."

ROB THRELKELD
Global Manager of Renewable Energy, General Motors

VIII. TRANSMISSION UPGRADES AND EXPANSION ARE NEEDED TO MEET GROWING CORPORATE DEMAND

Multiple studies have shown the need for more transmission to enable the continued development of the lowest-cost renewable resources. For example, the Department of Energy's *Wind Vision* report assesses the level of new transmission needed to meet 10 percent of the country's end-use demand with wind by 2020, 20 percent by 2030, and 35 percent by 2050.[42] The report found meeting these goals would require 10 million MW-miles of incremental transmission capacity by 2030 and cumulatively 29 million incremental MW-miles by 2050.[43] For comparison, the existing transmission system in the United States totals approximately 200 million MW-miles.[44] However, a key issue is that the U.S. must develop new transmission in the right places to transfer renewable energy from the places where it is produced to the places where it is used.

Further analysis of ISO and RTO interconnection queues—which show the capacity seeking transmission interconnection—demonstrates significant amounts of wind and solar are seeking transmission access. In 2016, 150 GW of wind and solar power capacity (equivalent to approximately 274 conventional power plants) entered interconnection queues compared to 40 GW of natural gas (equivalent to approximately 73 conventional power plants).[45] Wind and solar comprised 78.9 percent of the total resources seeking access to transmission.[46] MISO and SPP experienced especially sizable additions in 2016.[47] At the end of 2016, 142 GW of wind power capacity was seeking transmission interconnection, representing 34 percent of all generating capacity in the reviewed interconnection queues—higher than all other generating sources.[48]

Developing transmission requires detailed consideration of benefits and costs, which are beyond the scope of this report. But expanded transmission will benefit multiple parties in many ways (as discussed in Section X), and planners should consider its full range of benefits, as this will aid in allocating the costs of the project. Further, more potential projects could be planned and built with an improved FERC Order 1000 interregional planning process.

Analysis of how transmission can meet corporate renewable procurement goals and RPS demand

DGA conducted an analysis to determine whether currently proposed transmission lines could meet corporate procurement goals and Renewable Portfolio Standard (RPS) demand for renewable energy. RPS demand is not the only demand that should be accounted for in transmission planning; voluntary utility procurement of low-cost wind and solar resources will likely occur in the years that this analysis considers, as both resources are now the lowest cost electricity option in many areas. This procurement could be significant and will also need to be factored into transmission planning, but is outside the scope of this report.

We compared a high and low scenario for transmission construction with a high and low scenario for corporate renewable energy procurement, with RPS demand remaining the same across both scenarios. Our methodology is outlined in the following section.

As shown in Table 2, when we compared the conservative and aggressive scenarios for transmission build to the high and low corporate demand scenarios, we found:

- The conservative transmission scenario would meet only 42 percent of corporate renewable energy demand in the high scenario and 78 percent in the low demand scenario.
- The aggressive transmission scenario would meet 70 percent of high scenario for corporate renewable energy demand and over 100 percent in the low corporate renewable energy demand.
- Transmission planners should ensure that future transmission build is able to accommodate a high corporate procurement scenario—one that the current "aggressive" scenario is not able to accommodate.

Table 2. Percentage Demand Met by Proposed Transmission Lines

Scenarios	*High Corporate Procurement Scenario (51 GW), RPS Demand (15.5 GW)—66.5 GW Total Demand*	*Low Corporate Procurement Scenario (20 GW), RPS Demand (15.5 GW)—35.5 GW Total Demand*
Conservative Scenario (MW) [90% of planned transmission (Table 3) before 2020 is built, 20% of planned transmission after 2020 is built]	42%	78%
Aggressive Scenario (MW) [90% of *all* planned transmission (Table 3) is built]	70%	131%

The projected corporate procurement scenarios are significantly larger than the projected renewables needed to meet state RPS demand, which require utilities to supply a specified percentage of their electricity from renewable resources by a certain year.[49] The American Wind Energy Association (AWEA) estimates RPS policies will drive the development of approximately 15.5 GW of new wind power capacity from 2017 through 2025.[50] In the Low Corporate Procurement Scenario (20 GW), corporate procurement is nearly 1.3 times the size of the RPS demand and in the High Scenario (51 GW), corporate demand is nearly 3.3 times the RPS demand.

Corporate demand and transmission scenarios

The transmission construction in both the conservative and aggressive scenarios is based on the 14 proposed near-term transmission projects in advanced development that—if all were completed and fully subscribed—could carry 52 GW of new wind capacity, as shown in Table 3. Note that these lines will not exclusively serve renewable energy projects.

Table 3. Transmission Line Activity Serving Renewable Energy Projects

Transmission Project Name (State)	Voltage (kilovolts, kV)	Estimated In-service Date	Estimated Potential Wind Capacity (MW)[a]
MISO Multi-Value Projects (ND, SD, IA, MN, WI, IL, MO, MI)	345, one 765 line	2015-2020	14,000
Grand Prairie Gateway (IL)	345	2017	1,000
Southline Transmission Project (NM, AZ)	345, 230	2018-2020	1,000
Power for the Plains (NM, TX, OK)	115, 230, 345	2016-2020	1,230
Pawnee—Daniels Park (CO)	345	2019	600
Gateway West (WY, ID)	500	2019-2021	3,000
Empire State Connector (NY)	320 DC	2020	1,000
Transwest Express (WY)	600 DC	2020	3,000
Sunzia (NM, AZ)	500	2020	3,000
Clean Line Projects (KS, OK, IA, NM, AZ)	600 DC	2020+	16,000
Southern Cross (TX)	500 DC	2021	2,000
SPP 2012 ITP10 Projects (TX, OK, KS, MO)	345	2018-2022	3,500
Gateway South (WY, UT)	500	2020-2024	1,500
Boardman-Hemingway (OR, ID)	500	2022	1,000
Total Potential New Transmission Capacity			**~52 GW**

Source: AWEA, 2016 Annual Market Report

a The values in this column reflect the amount of wind capacity that can be connected to the lines. In some cases (e.g., Clean Line Projects) this total exceeds the delivery capacity of the line (due to diversity in wind output and losses). Additionally, in some cases the lines could add MW of other types of generation, such as solar, with minimal curtailment.

It is possible that not all of these projects will be completed, especially on the project timeline proposed by the project developers. For example, transmission projects might be unable to obtain land use rights and rights of way. To account for that possibility, DGA developed two investment scenarios: a conservative scenario and a more aggressive scenario, summarized in Table 4. In the conservative scenario, we assume there is a 90 percent success rate for the current proposed transmission projects (summarized in Table 3) through the year 2020. We then assume the likelihood of post-2020 transmission construction decreases to 20 percent of proposed lines. In the aggressive scenario, we assume there is a 90 percent success rate for *all* planned transmission lines, regardless of planned in-service date. This analysis assumes that all existing and planned transmission lines are fully subscribed.

Table 4. Transmission Line Activity Serving Renewable Energy Projects in Two Investment Scenarios

Scenarios	*Projects in Service By 2020 (MW)*	*Projects in Service After 2020 (MW)*	*Total Wind Capacity (MW)*
Total Estimated Potential Wind Capacity from AWEA Market Report (MW) [Table 3]	24,830	27,000	51,830
Conservative Scenario (MW), [90%, 20%]	22,347	5,400	27,747
Aggressive Scenario (MW), [90%, 90%]	22,347	24,300	46,647

We then compared those transmission scenarios with a high and a low scenario for corporate procurement. In the high scenario, we assume 51 GW of new corporate procurement. This estimate is from the Renewable Energy Buyers Alliance (REBA), a group of more than 100 large corporate buyers of renewable energy, which has a collective goal to purchase 60 GW of new renewable energy capacity in the U.S. by 2025 *minus* the amount of renewable energy procured by corporate energy buyers since 2013 (9 GW), when the Business Renewables Center at the Rocky Mountain Institute began tracking corporate deals.[51]

Because it is possible that this goal will not be achieved in its entirety, DGA assumed only 20 GW in its low scenario. However, considering that certain renewable energy generation technologies (including wind and most types of solar), are already the lowest-cost options across the country,[52] with projections suggesting costs will decline further in the coming years,[53] the high procurement scenario may be more likely. Corporates, who are increasingly setting public renewable energy targets, have been effective at working towards their commitments to date, which makes the near-term procurement of renewables even more likely. Further, the public nature of these corporate announcements may lead companies to be even more likely to achieve their targets, as failure to meet them could result in negatively publicity.

IX. TRANSMISSION PLANNERS SHOULD CONSIDER CORPORATE RENEWABLE DEMAND

Among other factors, transmission planners consider both supply and demand elements in making their recommendations. On the supply side, they must include taxes and incentives that affect the amount of renewable energy supply, as well as retirements of existing plants and line congestion. On the demand side, they must include factors that would drive significant demand, such as requirements for renewable energy (i.e., RPS policies), which 29 states have and the level of utility procurement.

Interviews DGA completed with RTOs revealed that planners do not factor in corporate or other non-utility institutional demand for renewable energy in RTO transmission planning despite the growing demand. Instead, RTOs typically only focus on mandatory renewable energy requirements prescribed by RPS policies and other renewable energy requirements. If a state has a mandate, such as an RPS, or other public goals, that assumption is sometimes included in transmission planning models and some RTOs will build infrastructure to meet the mandate.

However, in transmission planning, RTOs make little distinction between mandatory and voluntary state policies; RTOs generally treat each the same as long as they know the state policy.[54] For example, if a Governor issues a voluntary goal to develop 1 GW of renewable energy in the state, some RTOs would typically include assumptions to meet that 1 GW target in transmission planning models.[55] Although the goal may not be a mandate, it is a target that would weigh heavily in utilities' decision-making, and some RTOs would include it in the regional plan. Other RTOs do only what FERC requires, which is to "consider" public policy and may ultimately opt not to include state RPSs or other policies in their plans.

An important conclusion of this analysis is the distinction some transmission planners make between voluntary renewable energy goals which a Governor may establish and the voluntary goals which large corporations and other non-utility electricity buyers may have established is largely arbitrary. Planners should not only focus on meeting needs established by Governors, but also those of the largest electricity consumers.

Furthermore, transmission planners should start incorporating corporate demand for renewables into their planning efforts now, as the time needed to develop transmission lines is typically five to seven years.[56] FERC has already received extensive recommendations on how to strengthen the interregional planning processes, and should also consider recommending that transmission planners begin incorporating corporate demand into their future interregional planning meetings.[57]

X. EXPANDING TRANSMISSION PROVIDES ADDITIONAL BENEFITS

Cost Savings

It is well-documented that upgrading and expanding transmission can save consumers, including large energy users not signing PPAs, on their electricity bills by providing greater access to existing low-cost renewable energy resources and spurring further renewable development. Further, transmission expansion and upgrades can: (1) help meet state's ambitious renewable energy goals in a cost-effective manner; (2) create market efficiencies, leading to consumer savings; and (3) pay for themselves by reducing power losses and moving lower cost electricity to high demand areas.

Upgrading and expanding transmission can reduce the cost of meeting the growing customer demand for renewable energy in two ways. First, it enables customers to access a greater supply of potential low-cost projects from areas with lower-cost resources. Second, it can relieve congestion on transmission networks. Bottlenecks in the transmission system can lead to project output being curtailed, reducing its revenues and effectively raising its cost per unit of delivered output. Expanded and upgraded transmission infrastructure can reduce such curtailments. Transmission investments also facilitate robust wholesale market competition, enable a diverse and changing energy portfolio, and mitigate damage by limiting customer outages during adverse conditions.[58]

Numerous studies show how transmission can save money for customers.

In SPP:

- Transmission upgrades installed between 2012 and 2014 will create nearly $12 billion in net present value benefits for consumers over the next 40 years, or around $800 for each person currently served by SPP.[59] These savings are 3.5 times greater than the cost of the transmission upgrades. The transmission upgrades also contribute to a robust system that enables the effective integration and delivery of renewables across a wide geographic area. In their analysis, SPP found that 187 MW of new wind farms installed in 2014 would not have been interconnected to SPP absent the new transmission projects included in the analysis.[60]

- SPP customers have saved $900 million since the Integrated Marketplace began in March 2014, with much of the savings resulting from lower fuel costs as utilities were able to draw from a wider variety of generation sources.[61] According to Bruce Rew, vice president of operations at SPP, "[the Integrated Marketplace] allows us to optimize wind and low natural gas prices in our dispatch."

- Oklahoma Gas and Electric announced that its customers would see lower bills (a reduction of $5 for the typical residential customer) as the result of the benefits of SPP's Integrated Marketplace, which provided participants with net savings of $380 million in its first year.[62] Those savings would also not have been possible without adequate transmission facilities.

- Xcel Energy is refunding $18.6 million to Texas retail customers as a result of lower fuel and purchased power costs made possible by investments in SPP's transmission system.[63]

In MISO:

- MISO has approved 17 projects to upgrade and expand transmission known as Multi-Value Project lines that will expand renewable power in the region and lower electricity prices.[64]
- MISO found that the transmission upgrades are expected to:
    - Create $12.1 to $52.6 billion in net benefits over the next 20 to 40 years;
    - Enable 52.8 million MWh of wind energy to meet renewable energy mandates and goals through year 2031; and
    - Provide benefits in excess of its costs, with its benefit-to-cost ratio ranging from 2.2 to 3.4.[65]

Table 5 summarizes the quantified cost benefits to customers for SPP and MISO.

Specific transmission line projects also provide cost savings to ratepayers. For example:

- The proposed **Grain Belt Express Clean Line**, which draws from an area of especially high wind speeds in Kansas, would offer wind at less than 4 cents/kWh to customers in Missouri and PJM territory. Currently, the average price of electricity to Missouri customers is 11.60 cents/kWh (across all sectors).[66] The Grain Belt Express Clean Line is discussed further in the Case Studies section of this report.
- The **Badger Coulee line** in Wisconsin will provide access to low-cost electricity and spur the development of low-cost, fixed rate wind and solar projects – with consumer savings projected between $118 to $700 million.[67]
- The **Arrowhead-Weston line** in Wisconsin gave utilities access to low-cost electricity, saving $5.1 million for consumers in the first year of the project, and translating to an estimated $94 million in cost savings over 40 years.[68]
- The **ITC transmission line** projects in Michigan saved customers approximately $250 million in reduced cost to meet renewable requirements and Midwest projects saved customers approximately $337 million.[69]

Table 5. Summary of Costs Saving Benefits of Transmission for SPP and MISO

RTO/ISO	Description	NPV Benefits for Consumers
SPP	Transmission upgrades installed between 2012-2014	$12 billion over next 40 years
MISO	Transmission upgrades currently underway	$13 to 50 billion over next 20-40 years

Sources: SPP, The Value of Transmission*, and MISO,* MTEP14 MVP Triennial Review



Grid Reliability

Expanding and upgrading transmission helps create a flexible electric grid that ensures reliability. Utilities around the country are already witnessing the reliability benefits of a robust transmission system. For example, in December 2015, Southwestern Public Service Company (SPSC)—a member of SPP—was able to avoid a widespread outage thanks to the flexibility afforded by recent upgrades in their region. David Hudson, president of SPSC at a SPP board meeting stated, "We had a double fault at the Tolk coal plant where both units tripped off. Before we had this transmission, we would have had a widespread outage. But we went right through it…It's undeniable there's significant savings going on with this transmission."[70]

Transmission upgrades that facilitate the integration of wind and solar energy can help make the power system more flexible and efficient. Transmission also facilitates the integration of renewable energy by providing access to the best renewable sites and by allowing power to be moved from region to region in response to fluctuations in electricity supply and demand.[71] Wider areas of well-integrated transmission can also substantially mitigate the inherent variability of wind and solar generation, which fluctuates in local areas with increases and decreases in wind speed or cloud cover. Wind and solar have proven reliable for planning and dispatch purposes over a full planning region such as an ISO or RTO, as MISO and PJM have both learned.

Improved transmission infrastructure would also help avoid and/or defer future costs related to reliability upgrades and projects. For example, MISO estimates that over $300 million in future baseline reliability upgrades would be avoided by implementing the ISO's transmission portfolio of Multi-Value Projects.[72]

Air Quality Improvements and Carbon Emission Reductions

Delivering more renewable energy to corporate and other institutional customers would reduce emissions of carbon dioxide (CO_2) and other air pollutants. A recent study found that when using future anticipated costs for wind and solar, CO_2 emissions from the U.S. electricity sector can be reduced by up to 80 percent relative to 1990 levels, without an increase in the levelized cost of electricity.[73] Moving away from a regionally divided electricity sector to a national system enabled by high-voltage direct-current transmission would enable the U.S. to achieve this reduction in CO_2 emissions, according to the report.

Several studies have examined the effects of an expansion of clean energy transmission lines on carbon emissions levels. For example, MISO found that new transmission could result in an almost 50 percent reduction in GHG emissions by 2050.[74] In addition, a study of the PJM region found doubling wind energy through increased transmission infrastructure could deliver air quality improvements of 14 percent for carbon dioxide (CO_2), 10 percent for nitrogen oxides (NOx), and 6 percent for sulfur dioxide (SO_2).[75]



PJM: CLEAN LINE'S GRAIN BELT EXPRESS WILL UNLOCK RENEWABLE RESOURCES TO MEET CORPORATE DEMAND

The Grain Belt Express Clean Line will deliver approximately 4,000 MW of low-cost, renewable power and enough clean energy for 1.6 million homes per year and equal to the power from eight conventional power plants.

Companies such as GM, Unilever, P&G, Kellogg, and Nestlé characterize the project as "an opportunity to provide our companies with a link to low-cost renewable energy at a scale that is meaningful."

EXECUTIVE SUMMARY

The Clean Line Grain Belt Express is a proposed 780-mile high-voltage direct current (HVDC) transmission line that will originate near Dodge City, Kansas and deliver power to Missouri, Illinois, and surrounding states. It is a multi-RTO project that would deliver 4,000 MW of low-cost renewable power in total (enough to power 1.6 million homes per year); 3,500 MW of which would be delivered to PJM. The line would also benefit MISO and SPP, primarily by relieving congestion. Several major retail and manufacturing companies with significant renewable energy procurement goals publicly support the project; these companies include General Motors, Target, Unilever, Procter & Gamble, Kellogg, Nestle, and Walmart. This support from corporate renewable energy buyers represents a model of corporate engagement in transmission planning, which increasing corporate demand for renewable energy is driving.

BACKGROUND AND CONTEXT

The Grain Belt Express is a participant-funded, merchant model project. Its development and construction will be paid for by the renewable energy generators and load serving entities that purchase transmission capacity on the line. The line will enable approximately $7 billion of new renewable energy projects, which could not otherwise be built due to limitations of the existing electric transmission grid.

By utilizing DC technology, the Grain Belt Express will lower energy losses when moving large amounts of power over long distances, while using less land than comparable AC lines. The line will also result in improved electric reliability by utilizing direct current converter stations, allowing operators to control the flow of power.[76]

MAKING THE INVESTMENT

As a merchant transmission developer, Clean Line's investors are footing the costs of development. Clean Line must seek approval of the Grain Belt Express from the Public Utility Commission in each state through which it passes. Securing approval from all relevant regulatory bodies and stakeholders has been one of the most challenging aspects of the project. Kansas, Indiana, and Illinois have approved the Grain Belt Express. Clean Line is working through the process to obtain approval for

the Grain Belt Express in Missouri. Demonstrating the benefits of the Grain Belt Express for a diverse array of stakeholders has been instrumental in securing approvals. These benefits include cost savings, job creation, and pollution reduction. Specifically, the project is estimated to:

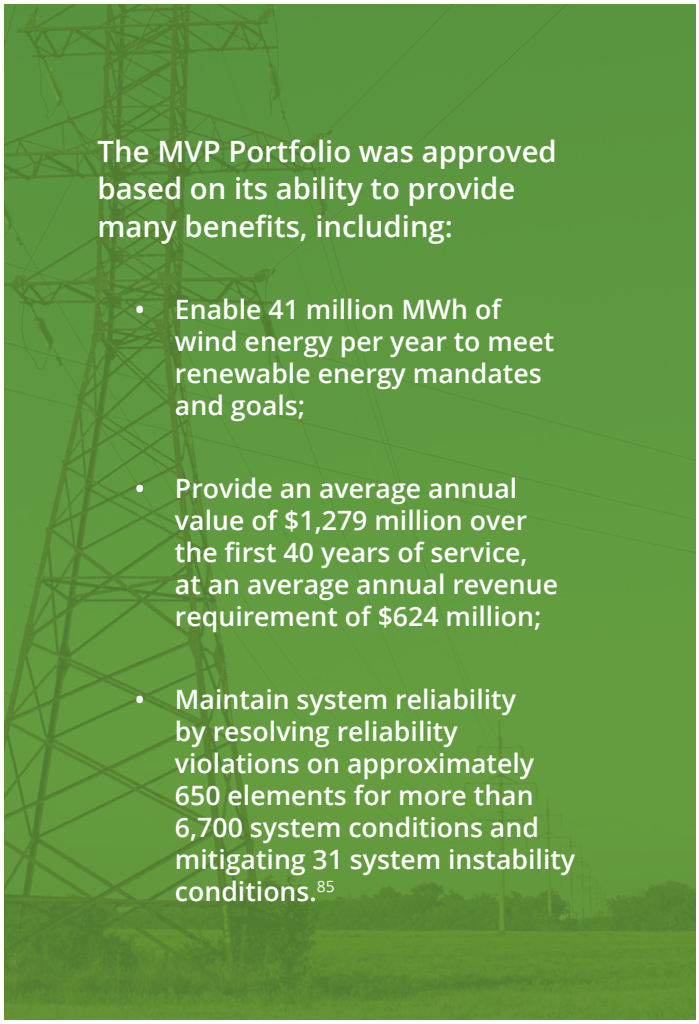
- Deliver energy to Missouri at less than 4 cents per kWh;
- Create more than 5,000 jobs to construct the transmission line and wind farms and more than 500 permanent jobs to maintain and operate the wind farms and the transmission line;
- Reduce CO_2 emissions by 14 million tons per year, nitrogen oxide emissions (a contributor to smog) by 10,000 tons per year, and sulfur dioxide emissions (a precursor to acid rain) by 22,000 tons per year.[77]
- The project was $2.2 billion investment, providing economic benefits for the states that host the line.[78]

Business support for the Grain Belt Express has been broad. In 2016, a group of companies with retail and manufacturing facilities across Missouri including General Motors, Unilever, P&G, Kellogg Company, and Nestlé, joined in supporting the Grain Belt Express project. These companies, which collectively employ more than 10,000 Missourians and own dozens of facilities across the state, each have corporate sustainability goals and are a part of a broader trend of companies around the country using their purchasing power to call for more renewable energy. The companies stated in its letter, "Access to renewable energy is increasingly important to our decisions about where to expand and to site new facilities."

The Missouri Industrial Energy Consumers (MIEC), an association of some of Missouri's largest energy consumers, also commended the Grain Belt Express project. "Low energy prices allow Missouri businesses to thrive and access to renewable energy is essential to many of our members' sustainability goals," said Diana Vuylsteke, who represents the MIEC on issues pertaining to energy. "It is imperative that we take advantage of free-market solutions like the Grain Belt Express to meet our energy needs."



MISO: MULTI-VALUE PROJECT (MVP) PORTFOLIO WILL HELP CORPORATE ENERGY BUYERS IN THE MIDWEST ACCESS RENEWABLES



The MVP Portfolio was approved based on its ability to provide many benefits, including:

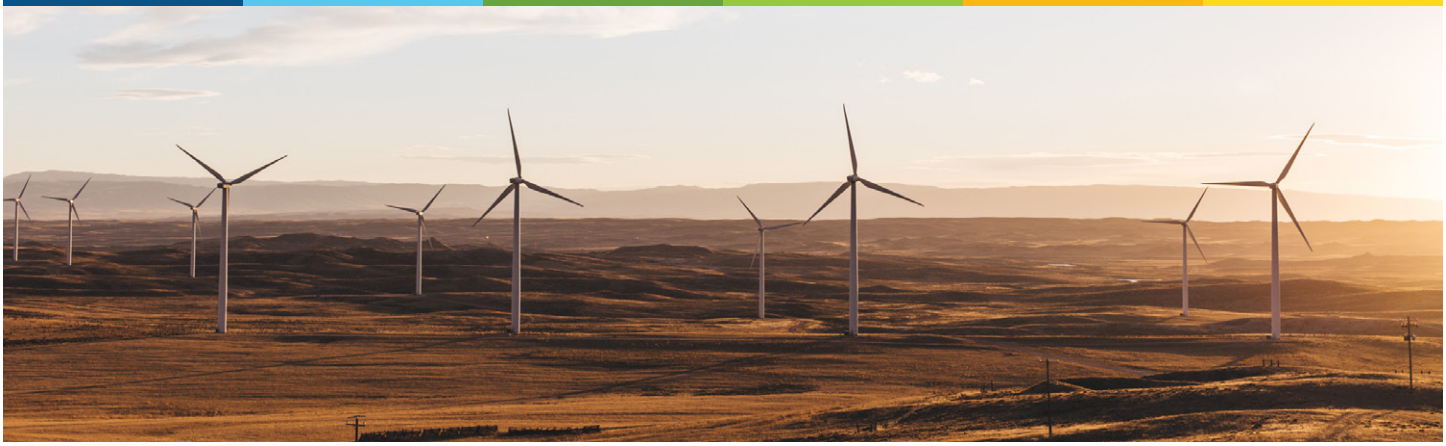
- **Enable 41 million MWh of wind energy per year to meet renewable energy mandates and goals;**
- **Provide an average annual value of $1,279 million over the first 40 years of service, at an average annual revenue requirement of $624 million;**
- **Maintain system reliability by resolving reliability violations on approximately 650 elements for more than 6,700 system conditions and mitigating 31 system instability conditions.[85]**

EXECUTIVE SUMMARY

The relatively recent adoption of RPS policies and clean energy goals across MISO's footprint have resulted in the need for a more expanded and upgraded transmission system to deliver renewable resources from often remote renewable energy generators to load centers.

To meet this increasing demand, MISO proposed the Multi-Value Project (MVP) portfolio, which contains 17 transmission projects that span eight states (Table 6). These proposed lines collectively are estimated to: (1) provide benefits in excess of costs; (2) create $12.1 to $52.6 billion in net benefits over the next 20 to 40 years; and (3) enable 52.8 million MWh of wind energy to meet renewable energy mandates and goals through year 2031.[79]

As a testament to the importance of transmission as a necessary component for renewable energy development—to deliver energy from rural areas to end users in urban locations—GM has recently announced a 200 MW wind purchase which will power all of the company's Ohio and Indiana manufacturing facilities from wind farms located in Ohio and Illinois.[80] Once the turbines come online by the end of 2018, renewable energy will power 20 percent of GM's global electricity use. This project would not have been made possible without a robust transmission system in MISO territory.



BACKGROUND AND CONTEXT

MISO's recommended MVP portfolio is comprised of the 17 projects detailed in Table 6. The portfolio of projects will enable enough wind integration into the MISO footprint to fulfill RPS goals through at least 2026.[81]

Table 6. MISO Multi-Value Project Portfolio[82]

	Project	State	Voltage (kV)	In Service Year	Cost (M, 2011$)
1	Big Stone-Brookings	SD	345	2017	$191
2	Brookings, SD-SE Twin Cities	MN/SD	345	2015	$695
3	Lakefield Jct.-Winnebago-Winco-Burt area & Sheldon-Burt area-Webster	MN/IA	345	2016	$506
4	Winco-Lime Creek-Emery-Black Hawk-Hazleton	IA	345	2015	$480
5	N. LaCrosse-N. Madison-Cardinal & Dubuque Co.-Spring Green-Cardinal	WI	345	2018/2020	$714
6	Ellendale-Big Stone	ND/SD	345	2019	$261
7	Adair-Ottumwa	IA/MO	345	2017	$152
8	Adair-Palmyra Tap	MO/IL	345	2018	$98
9	Palmyra Tap-Quincy-Merdosia-Ipava & Meredosia-Pawnee	IL	345	2016/2017	$392
10	Pawnee-Pana	IL	345	2018	$88
11	Pana-Mt. Zion-Kansas-Sugar Creek	IL/IN	345	2018/2019	$284
12	Reynolds-Burr Oak-Hiple	IN	345	2019	$271
13	Michigan Thumb Loop Expansion	MI	345	2015	$510
14	Reynolds-Greentown	IN	765	2018	$245
15	Pleasant Prairie-Zion Energy Center	WI/IL	345	2014	$26
16	Fargo-Galesburg-Oak Grove	IL	345	2018	$193
17	Sidney-Rising	IL	345	2016	$90
Total					**$5,197**

MAKING THE INVESTMENT

In 2017, MISO performed its second triennial review of the MVP Portfolio benefits. The MVP Portfolio was studied and approved in 2011 as a part of MISO's annual transmission expansion plan, with a tariff requirement to conduct a full review every three years.[83] The analysis found that the MVP projects would: (1) provide benefits in excess of its costs; (2) create $12.1 to $52.6 *billion* in net benefits over the next 20 to 40 years; and (3) enable 52.8 million MWh of wind energy to meet renewable energy mandates and goals through year 2031.[84]

ERCOT: CREZ LINES ENABLE AMAZON & OTHER CORPORATE PURCHASERS TO PROCURE RENEWABLE ENERGY



EXECUTIVE SUMMARY

A long-time leader in wind power development, Texas is home to some of the best wind and solar resources in the nation. In the early 2000s, state legislators recognized a need for additional transmission in West Texas and the Panhandle to enable more renewable development. The Public Utility Commission of Texas (PUCT), working with the Electric Reliability Council of Texas (ERCOT) and at the direction of the state legislature, conceived and developed Competitive Renewable Energy Zones (CREZ) to facilitate the development of the state's renewable assets.

Completed in 2014, the CREZ transmission lines have now enabled 18,000 megawatts (MW) of new capacity and attracted billions of dollars in investment in the state from wind and solar developers. Those projects, combined with the state's deregulated energy market, have also garnered the attention of many large corporations seeking the fixed-rate pricing and environmental benefits of renewable energy. As a result, at least 14 major corporations have purchased renewable energy from Texas projects.

One such project, Amazon's 2016 purchase of 90 percent of the power generated from a 253 MW wind project in Scurry County, Texas was the company's largest to date. The project, now known as Amazon Wind Farm Texas, was enabled by CREZ transmission lines and is projected to bring over 250 construction jobs and $290 million in new investment to the county.

BACKGROUND AND CONTEXT

Amazon, the e-commerce and cloud computing company, is not only a revolutionary force in business but in corporate sustainability efforts as well. By purchasing stable, low-cost wind and solar energy, the company is able to keep their energy costs down and pass the savings onto customers.[86] In 2016, Amazon was the leading corporate purchaser of renewable energy in the U.S., with 3.6 million MWh of renewable energy purchases announced or projects commencing construction.[87] Amazon Web Services (AWS), a subsidiary of Amazon, has a long-term commitment to achieve 100 percent renewable energy usage for their global infrastructure footprint. AWS exceeded its goal of 40 percent renewable energy by the end of 2016, and set has a new goal of 50 percent renewable energy by the end of 2017. But achieving these ambitious goals is likely dependent on the continued expansion and upgrades to the nation's transmission infrastructure.

In the early 2000s, Texas faced a "chicken or the egg" dilemma as the wind industry began to take off.[88] Recent wind development had overwhelmed existing transmission, resulting in curtailment and network congestion, and thwarting further investment.[89] More transmission was needed, but new lines were typically only built once a generator committed to building, and generators would only build once there was a commitment to build transmission.[90]

To solve the issue, Republican State Senator Troy Frasier introduced Senate Bill (SB) 20 in 2005, directing the PUCT to implement a large-scale transmission build-out with the goal of generating more capacity from renewables.[91] The bill received bipartisan support, as conservatives in the West touted the economic development, while liberals in the East lauded its potential to lower electricity prices. A diverse set of energy and electric stakeholders also supported the bill, including Public Citizen, Direct Energy, Texas Public Power Association, FPL Energy, and the Association of Electric Companies of Texas.[92] With overwhelming bipartisan support in the legislature, the bill easily passed in both chambers.[93]

After SB 20 became law, the PUCT tasked ERCOT with identifying wind energy production potential statewide and the possible transmission constraints impeding its delivery.[94] Using ERCOT's study, the PUCT developed a transmission system to optimize the vast wind resources in West Texas and the Panhandle.[95] With construction beginning in 2009, the projects took 5 years to build and cost $6.9 billion, but created a pipeline which delivered the abundant supply of low-cost wind power to areas of significant demand in the eastern portion of the state.[96]

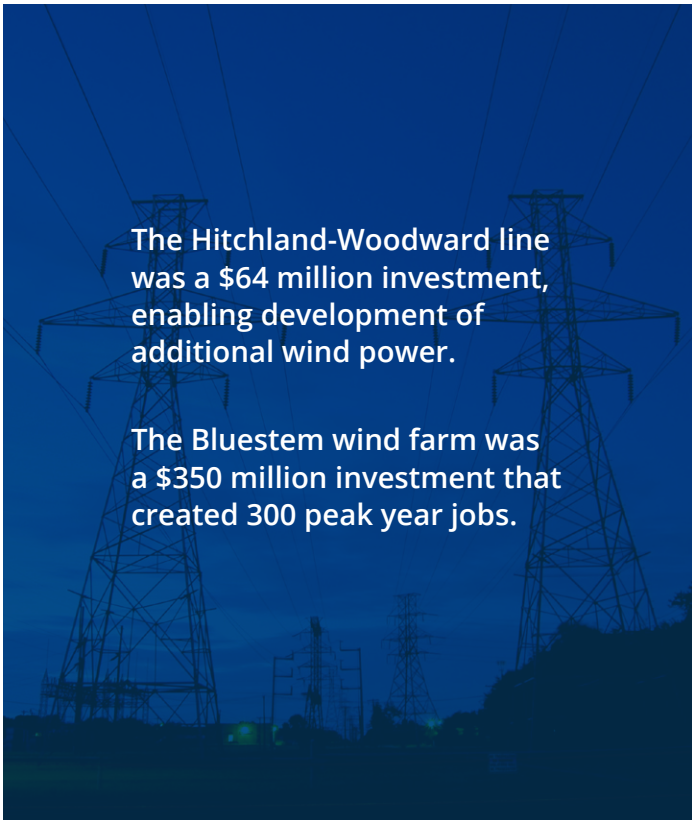
Completion of the CREZ lines eliminated the congestion and curtailment and unlocked an additional 18,000 MW of capacity.[97] Previously untapped wind-rich regions were now open for business, breeding competition and stimulating development of high quality projects at the least cost.[98] In the two years following the completion of CREZ projects, 2014 and 2015, an average of over 2,600 MW of wind capacity was installed, compared to an average of 738 MW in the four years prior.[99]

With the new lines in place, corporate purchasers like Amazon, with large energy loads and ambitious clean energy targets, were increasingly drawn to Texas renewable energy projects. Corporate purchasers have now signed PPAs with at least 14 wind projects directly connected to CREZ lines.[100]

MAKING THE INVESTMENT

Amazon purchases 227.7 MW of the 253 MW project in Scurry County known as Amazon Wind Farm Texas. The project consists of over 100 turbines that will generate over 1 million MWh of wind power annually.[101] The wind farm is expected to bring over 250 construction jobs and $290 million in new investment to the county, and will connect to a portion of the CREZ line developed by Oncor Electric Delivery.[102] Oncor was awarded the rights to build 25 percent of the CREZ lines, totaling 1,037 miles of transmission.[103] The transmission segment that the Amazon Wind Farm connects with brought over $1 billion of investment and over 1,500 peak year jobs to the state.[104]





SPP: HITCHLAND-WOODWARD TRANSMISSION LINE ENABLES GOOGLE TO PROCURE LOW-COST RENEWABLE ENERGY

EXECUTIVE SUMMARY

Recently completed transmission projects, such as the Hitchland-Woodward line in the Southwest Power Pool (SPP), have enabled the development of low-cost wind projects. These projects, in turn, have attracted the attention of corporates buyers with renewable energy goals such as Google. As noted, corporate purchasers have set a 60 GW goal for renewable energy purchases by 2025, and will likely continue to heavily rely on wind and solar energy generated in SPP to meet that demand.

BACKGROUND AND CONTEXT

In 2012, Google, the search engine and technology company, pledged it would purchase enough renewable energy to meet 100 percent of the electricity needs of its operations.[105] Google seeks to accomplish two important goals in every renewable energy purchase: create additionality and the highest possible positive impact on the renewable energy industry.[106] Through direct energy purchases, renewable energy certificates, and partnerships with utilities to purchase renewables, Google will achieve their goal by the end of 2017.[107] Their renewable energy purchases, in five different countries across three continents, will total over $3.5 billion in capital investment, and generate tens of millions of dollars in local taxes and land lease payments.[108] Google's long-term goal is to power their operations on a region-specific, 24/7 basis with clean, zero-carbon energy.[109] But to achieve this more challenging goal in a cost-effective manner, the U.S. transmission infrastructure will likely need further upgrades and expansion to enable access to more low-cost renewable resources.

Much of these resources reside in states located within SPP, and recent transmission upgrades and expansion have just begun to unlock their potential. Between 2012 and 2014, utilities in SPP spent $700 million on transmission improvements, an 84 percent increase compared to 2009–2011 spending.[110]

Oklahoma and Kansas particularly benefitted from these investments. As a result, 30 and 25 percent of the electricity generated in Oklahoma and Kansas, respectively, comes from wind power.[111] Development is not expected to slow down in these states, either. By 2021, installed wind capacity in the two states is expected increase another 9 percent.[112]



Xcel Energy and Oklahoma Gas & Electric were responsible for developing several of the SPP transmission projects, including a project to improve energy access in the Oklahoma Panhandle.[113] One of these projects, the Hitchland-Woodward line, improved regional reliability and helped enable the development of more low-cost wind power, including the Bluestem Wind Farm.[114] Google now purchases the power generated by Bluestem.

MAKING THE INVESTMENT

Completed in May 2014, the Hitchland-Woodward line was a $64 million investment that enabled Xcel Energy to idle less efficient plants in the off-peak season, boost grid reliability, and import greater supplies of less expensive power from neighboring power plants.[115] It also enabled the development of the Bluestem Wind Farm.[116]

Located in Beaver County, Oklahoma, and connected to the Hitchland-Woodward line, the Bluestem Wind Farm is a 60 turbine, 198 MW project that was brought online in early 2017.[117] The wind farm represented a $350 million investment and created 300 peak year jobs.[118]

Without the Hitchland line, however, the Bluestem project would not likely have been built. Bluestem project developer, RES Americas, had leased land in the Panhandle knowing that their potential projects were only possible if additional transmission lines were completed.[119]

In 2008, a study developed for SPP recommended the construction of a transmission line between the Hitchland and Woodward substations because models of the current and potential wind output in the Oklahoma Panhandle overloaded transmission capacity.[120] Based on that recommendation, Xcel Energy began development of the project and in May 2014, the Hitchland-Woodward line went into service. Nineteen months later, construction of the Bluestem Wind Farm began, directly connecting to the Hitchland-Woodward line.[121] Around the same time, RES Americas, the developer, struck a long-term PPA with Google for the project.[122]

XII. CONCLUSION

Our analysis finds that upgrading and expanding transmission is essential to deliver significant amounts of new renewable energy to large customers. Four key findings arose from this analysis:

1. Corporate demand for cheap, clean renewable energy is growing.
2. Renewable energy production and potential is concentrated in the central U.S. region, far from most future electricity demand.
3. New transmission is needed to meet this growing demand.
4. Transmission planners are typically not incorporating this rising tide of voluntary corporate renewable energy demand into plans to build new transmission.

Based on these findings, we recommend that corporate buyers and other large institutional customers:

- Encourage transmission planners and state Public Service Commissions to increase access to affordable, renewable energy by approving upgrades and expansion to transmission lines;
- Participate in regional and inter-regional transmission planning conversations to ensure future transmission infrastructure meets customer demand for renewable energy; and
- Urge FERC to continue work to improve interregional planning processes consistent with Order 1000.

We recommend that operators of Regional Transmission Organizations:

- Incorporate voluntary, large customer demand in transmission planning.
- Strengthen planning across RTOs and other regional planning authorities to ensure efficient interregional transmission.





XIII. RESEARCH METHODOLOGY

This report, which focuses primarily on the Eastern Interconnection and ERCOT, is based on reviews of online literature on transmission, as well as a series of interviews with companies, RTOs, and ISOs. See Appendix B for a list of interviewees.

XIV. APPENDIX A: INTERVIEWS

DGA and WEF interviewed the following experts to inform this analysis:

Warren Lasher, Senior Director of System Planning, ERCOT

Lanny Nickell, Vice President, Engineering, SPP

Mark Lawlor, Vice President, Development, Clean Line

Ron Stimmel, Senior Program Manager, Global Renewable Energy Strategy, Amazon

Neha Palmer, Head of Energy Strategy, Google

Michael Terrell, Head of Energy Market Development, Google

Jayshree Desai, Chief Operating Officer, Clean Line Energy Partners

Bill White, Director of Business Development, Northeastern United States, CTC Global

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Wind Energy Foundation

The Wind Energy Foundation is a 501c3 nonprofit organizations dedicated to raising public awareness of wind as a clean, domestic energy source through communication, research, and education. The Foundation is also committed to supporting ongoing research that furthers the continued growth of wind energy. For more information, visit www.windenergyfoundation.org. A Renewable America (ARA), a campaign to educate on the economic benefits of the growing wind and solar industries and the transmission and storage technologies that support them, is a project of the Foundation. To learn more, visit: www.arenewableamerica.org.

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