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States of transmission: Moving towards large-scale wind power

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HIGHLIGHTS

- We present a comparative case study of state-level contexts linking wind and transmission.
- Barriers for wind transmission are identified based on stakeholder interview data.
- Framing of transmission issues was related to importer/exporter status.
- Local grid features and the role of wind in the power supply also proved important.

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ABSTRACT

Efforts to plan and site transmission for wind power cannot currently keep pace with wind power development. The very nature of wind power, whether distributed or intermittent, challenges traditional models of electricity grid development. Much of the decision authority for transmission is located at the state level, creating tensions between a system-wide need for transmission capacity and the local nature of planning and implementation. This study identifies and discusses barriers for wind power transmission and highlights the critical role of states and state policies in expanding and transforming the electricity grid to accommodate large scale wind power. Drawing on extensive interview data with energy stakeholders, we present a comparative case study of state-level contexts linking wind and transmission in Montana, Minnesota, and Texas. Stakeholders were found to portray transmission challenges and solutions for wind power based on the character of the local transmission grid, their status as power importer, exporter or self-sufficient state, and the role wind already plays in the power supply.

1. Introduction

"The list of top three [challenges] for wind industry I would say: transmission, transmission, and transmission." –Texas Energy Stakeholder

For the first time, transmission of renewable energy was the subject of a federal U.S. Senate hearing in 2010 (Wagman, 2010), demonstrating increasing attention to infrastructure development as a central step towards continued expansion of sustainable electricity resources. While state and regional efforts to plan and site wind power projects and associated transmission lines have been on-going for the past decade, the distributed nature of renewable power, comparatively small capacity of renewable energy facilities, and the complexity of integrating intermittent power sources into the grid challenge the current transmission infrastructure across the United States. Renewable energy, especially wind power, affects and alters transmission planning and operation. Conventionally, U.S. utilities built transmission lines to integrate large stationary power plants in response to projected electricity demand increases. For renewable energy, this process is largely reversed, as its development is less 'market pull', than 'regulatory push' emanating from state mandates for renewable energy that have created the need for new transmission lines (Brown and Rossi, 2010; Piszczalski, 2009).

Proposed solutions for renewable energy's transmission problems range from the local to the national and include building coast-to-coast "green super highways" (AWEA, 2009) that connect load centers with wind resources, or alternatively, integrating wind power into the grid in a more distributed manner (Rhoads-Weaver and Forsyth, 2006). No matter which solutions

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are chosen, more transmission capacity is needed. In addition to regional planning and coordination, this will involve the states, as the most important gatekeepers for interstate transmission are at the state-level (Oskvig, 2008). There is an inherent tension between a system-wide need for transmission capacity and the localized nature of planning and implementation (Brown and Rossi, 2010).

Transmission has been identified as a barrier to renewable energy development (Oskvig, 2008) and the underlying factors complicating transmission planning are well known (Bloom et al., 2010; Porter et al., 2009). In this discussion, the state level context for renewable energy transmission planning and implementation has received little attention although it is critical to renewable energy development. From state to state, factors facilitating or supporting transmission play out in very different ways. Therefore, this paper addresses the following questions: How is transmission for wind power perceived and addressed within a state context? Do stakeholders differ in their perceptions and proposed solutions for wind power transmission? This research explores how state-level energy policy stakeholders portray the challenges and opportunities of wind power and transmission. It provides insights into the state-level socio-political contexts for transmission development. Interviews of state-level energy policy stakeholders were conducted in three states with large wind resources, but varying levels of wind power and transmission build-out: Montana, Minnesota and Texas.[1] Content analysis of these interviews demonstrates that transmission is one of the most challenging and contentious aspects of wind power growth, and energy policy stakeholders across all three states recognize its critical importance. Transmission challenges, however, are envisioned and addressed differently across states.

2. The critical role of transmission in facilitating renewable power development

Renewable energy production continues to expand rapidly, helping to reduce pressing energy/environmental problems and to meet state-level commitments to generate electricity from renewable energy. For the first time, the Federal Energy Regulatory Commission (FERC), recognizing the need for coast to coast transmission for renewables, instigated a series of planning meetings in 2009 (Piszczalski, 2009). We focus this article on wind power. Wind has taken a central place in the discussion about renewable energy transmission, because 94% of non-hydro renewable development in the United States since 1998 has been from wind (Wiser et al., 2011) and wind became the fastest growing energy resource in the United Stated the late 2000s. Due to sheer size, transmission challenges are not as pronounced for other renewable resources (with the possible exception of large-scale solar power), although they may face other challenges. For instance, small scale solar power development requires solutions for net metering and distributed grids. A special challenge for wind power transmission is that the best wind resources are often far from population centers, meaning that exploiting them will not be possible without building more transmission. The unequal distribution of wind resources across the United States also raises questions related to state-to-state import and export of wind power.

The current infrastructure supporting wind power transmission has arisen out of a regionalized grid structure. Fig. 1 provides an overview of the distribution of wind power projects across the United States, and how they relate to existing and planned transmission lines and regional transmission organization areas. It highlights the challenges between wind and transmission in a graphical form, showing the distance between load and resource and depicting the regionalized nature of the US grid. Wind projects are very unevenly distributed across the United States and across regional transmission organizations, which operate local grids (Fig. 1a). It is also interesting to examine the relationship between wind projects and transmission lines. Current and planned wind projects are not necessarily located close to existing major transmission lines. Much of the planned transmission will connect the sites with the largest wind power concentration to major population and load centers. This demonstrates that local and regional planners have begun to address wind power transmission.

Even with these new state and regional planning efforts to link renewable energy to the grid, fundamental institutional challenges persist. The structure of the US energy supply system presents one such challenge. US regional electric grids can be described as "fractured along utility and regional lines, minimally interconnected, and mostly isolated from [their] larger neighbors, even when they are next door" (Maize, 2008). Historically, the U.S. electricity market has been dominated by vertically integrated utilities, which also operated control areas and maintained interconnections for reliability reasons only (Joskow, 2005). Transmission lines were generally built when a new, large stationary power plant justified their need. Renewable power facilities are much smaller than conventional power plants and often do not pass the threshold required to obtain a certificate of need for a new power line. For utilities or independent operators, building a new transmission line without power production already in place is risky (Talbot, 2009).

A less centralized grid structure could facilitate the interconnection of small renewable sources, while increased connectivity across regional grids could help balance the intermittency of wind power across sites by taking advantage of non-correlated wind resources (Archer and Jacobson, 2007; DeCarolis and Keith, 2006). The power production of non-correlated wind resources is independent of each other, generally due to spatial diversity, meaning that by integrating such resources into the grid, the problem of intermittency is addressed. Currently, decentralization, the lack of available interconnections, and insufficient transmission capacity all hinder wind power development. This is exacerbated by long-standing underinvestment in transmission capacity and ensuing grid congestion. The Energy Policy Act of 1992, and later state-level deregulation efforts, have allowed the entry of independent generators into the electricity market by giving them access to incumbent regulated utilities' transmission networks (Sharabaroff et al., 2009). Regulatory reform aimed at increasing competition in the electric utility sector had the unintended consequence of simultaneously discouraging transmission development. A system that deregulated generation, but not transmission and distribution, burdened incumbent firms with the stranded costs of infrastructure investment (Sharabaroff et al., 2009), and established a strong disincentive for investing in transmission lines. Deregulated energy markets also added to grid congestion, as power was now sold – and therefore transmitted – over longer distances (Talbot, 2009).

Given that the electric power grid is maladapted to accommodate more renewable power, with wind power already being curtailed – 7% in Texas to 2.2% in the Midwest (Ryan Wiser and

[1] The original study also included the state of Massachusetts. Given the contentious nature of wind power in this state, little new wind power has been built and transmission aspects found little mention in the interviews conducted. Consequently, this state was excluded in the present paper. Nevertheless, significant build-out of transmission capacity will be required in the North-Eastern United States to achieve higher penetration of wind power (Corbus et al., 2009).