A CRITICAL REVIEW OF WIND TRANSMISSION COST ESTIMATES FROM MAJOR TRANSMISSION PLANNING EFFORTS

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Overview

Differences between conventional power and wind power make transmission more important to wind projects than to conventional power plants. The location of wind farms is dependent on the wind resource, which is often some distance from loads. Wind projects also have a low capacity factor compared to baseload power plants. These issues lead to concerns that the cost of transmission per kWh generated may be excessive compared to other generation options.

Unfortunately, transmission planning is a relatively complex, data-intensive process that does not lend itself well to simplified analysis. We approach the question of the cost of transmission for wind through a meta-analysis of 17 regional transmission planning studies from across the United States that include accessing new wind resources. While the transmission studies usually provide only first-order cost estimates, the results reveal that, in many cases, concerns about extremely high costs of transmission for wind are unfounded.

Generally, we include in our sample transmission expansion plans that evaluate 300 MW or more of new wind power and focus on the deeper network upgrades required to ship power from wind resource regions to load centers. The spectrum of studies ranges from very conceptual pre-feasibility evaluations of potential transmission solutions to highly detailed studies that model system impacts such as thermal overloads of specific facilities, excessive voltage drop along particular paths, or stability criteria.

Methods

Our simplified approach is to extract the total required transmission investment from scenarios in transmission planning studies that involve wind and divide the cost by the relative share of capacity and energy from the modeled wind resource. Based on the transmission costs, we estimate the unit cost of transmission upgrades weighted by generator capacity and weighted by energy. The typically higher capacity-weighted number represents the cost of transmission assuming that transmission must be reserved for the full capacity of the wind power plant at all times. The typically lower energy-weighted number represents the assumption that transmission costs are allocated based on the average power output of a resource, not its peak capacity.

In addition to the unit cost of transmission, we collect information from each study that allows us to assess factors that drive the differences in the unit cost of wind transmission. By collecting the total miles of transmission that are built in each case, we calculate the average cost of transmission per MW of new generation capacity per mile of transmission line ($/MW-mi). The $/MW-mi statistic reveals differences in network conditions where transmission investments are made.

Results

The amount of new wind generation evaluated in the studies ranged from 500 MW to 25.5 GW. Many of the studies simultaneously – i.e., within the high-wind scenario – studied other various new generation options including coal, gas, and other renewables. When included, the new non-wind generation ranged from 300 MW to 37.6 GW. The transmission solutions required to deliver the new generation to load centers almost always included new high-voltage transmission lines. One study, however could connect 500 MW of new wind with only an upgrade to a substation. The total cost of new transmission facilities ranged from $25 million in for 500 MW of additional wind in the Buffalo Ridge area of Minnesota to $31 billion to ship 16 GW of wind energy from the western regions of the Midwest ISO to states in the Northeast.

We use in-depth reviews of each of the transmission studies to collect sufficient information to assess the unit cost of transmission for wind based on both the capacity of the new wind plants and the volume of energy expected to be produced by the wind plants based on simplifying assumptions. The unit cost of wind transmission is presented in Figure 1in $/MWh-wind terms.

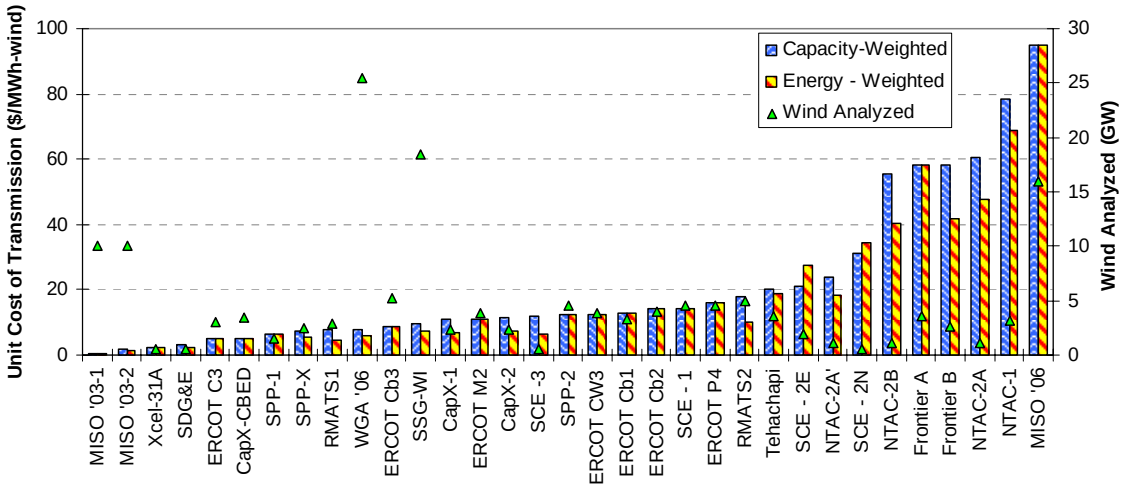

Figure 1. Unit cost of transmission for wind in $/MWh-wind terms

The wide variety of regions, modeling methods, network conditions, and assumptions in the studies lead to an equally wide range of unit costs for wind transmission. The range of costs is from $0.40 to 95/MWh or $8.5 to $1,940/kW. However, nearly 75% of the scenarios studied cost less than around $20/MWh or $420/kW weighted by either capacity or energy. The median cost of transmission is around $11-12/MWh or $225-250/kW.

Conclusions

In nearly 75% of the scenarios evaluated among our 17 studies, the unit cost of wind transmission was less than $20/MWh. Furthermore, all but a few of these scenarios modeled more than 2 GW of new wind simultaneously connecting to the transmission network with a small number modeling more than 5 GW of new wind. Based on these scenarios, there is significant potential to develop new wind resources through proactive transmission planning without paying extraordinarily high costs. On the other hand, not all projects are economically justifiable. The most expensive transmission plan, would cost $95/MWh, which clearly is an extraordinarily high cost for building new transmission.

While we have estimated the unit cost of transmission for wind projects across the United State, the values we present should not necessarily be interpreted as a transmission cost adder to the bus bar cost of wind. None of the studies had the objective of establishing a wind transmission cost adder. Nevertheless, with our simplified methodology the majority of scenarios lead to a reasonable unit cost for accessing new wind resources

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