



# Policy Brief

Stanford Institute for Economic Policy Research

## The Benefits of an Electron Superhighway

By Frank A. Wolak

Calls for expanding the electricity transmission network in the wake of the blackout in the Northeast have emphasized reliability and security. There's another reason to invest in the power grid: It will make electricity cheaper for consumers. This is because more transmission capacity increases the geographic size of the market any supplier can serve. Because each supplier faces a larger number of competitors able to sell energy at their location in the transmission network, this increases the competitiveness of the wholesale market, which leads to lower prices.

The ability to move more products around the country at lower cost expands the size of any supplier's market. California provides a historic example. The transcontinental rail network dramatically expanded the size of the market for California fruits and vegetables, and benefited not only farmers here but also consumers throughout the United States.

The same is true for electricity. The towers and wires of the transmission system are like the train tracks. A transmission network with plenty of capacity can bring electricity to consumers from far away, and this power can often be produced less expensively than local power or in a more environmentally friendly manner.

The recent blackout in the eastern United States demonstrates that an inadequate transmission network can also impose enormous economic harm, just as an overcrowded railroad network can leave fruit rotting in boxcars and create supply shortfalls that cause prices to spike at certain locations in the United States.

### Transmission Expansion to Enhance the Efficiency of Wholesale Electricity Markets

The U.S. electricity supply industry has an urgent need for additional transmission capacity. An increasing share of the electricity consumed in the United States is purchased from a wholesale market instead of being provided by the local utility from its own power plants. During the former vertically integrated utility regime, the same entity that sold electricity to final consumers owned the generation units that produced it, the transmission facilities to transport it, and the distribution network to deliver it to consumers. This would be analogous to the same entity that owns the rail network owning all of the trains that run on it and producing all of the goods transported by rail.

With a single vertically integrated owner of the rail network, cars, and goods produced, this operator should be able to get by with a less extensive rail network and still reliably deliver the same quantity of goods as the case where the regional rail network was open to all rail car owners and goods producers. This single firm could tailor each aspect of the process of producing and delivering goods to consumers to all other aspects of this process, because it would capture the full benefits of each of these investments.

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Similar logic applies to the case of electricity. A single company owning virtually all generation facilities and the entire transmission and distribution network for a single geographic area could reliably serve the same number of consumers with less transmission capacity than would be necessary if the transmission network was available to all generation-unit owners and electricity retailers on an open-access basis.

This result holds because there are two ways to meet an increase in electricity demand at a given location: Build more nearby generation, or increase the transmission capacity into the region to bring in more distant generation. The former vertically integrated utility could treat these two options symmetrically. Because of the financial separation between generation and transmission network ownership and these two functions and system operation in a wholesale market regime, there is no longer a single entity able to exploit this tradeoff between generation and transmission to meet a local energy need.

In regions with formal wholesale markets, such as California and much of the eastern United States, the transmission network is operated by an independent entity. Suppliers bid for the right to sell electricity from their generation units, with those bidding the lowest prices winning the right to produce electricity from their generation units. If there is adequate transmission capacity to face each generation-unit owner with significant competition from a number of other financially independent suppliers — what I call an economically reliable transmission network — then all suppliers will find it in their unilateral financial interest to bid as close as possible to their variable cost of producing energy.

However, if the transmission network into a region does not have enough capacity to face a local supplier with sufficient competition from distant suppliers, the local supplier may find it more profitable to withhold output from its generation units. If this local supplier withholds enough output, the transmission lines into this region will be filled to capacity with electricity, because more of the region's demand must be met by distant suppliers. Once these transmission lines are congested (filled to capacity), the local supplier is a monopolist facing a completely price inelastic demand for the remaining amount of energy that cannot be supplied by distant generation units because of transmission capacity constraints.

Without explicit regulatory intervention, the local supplier can name its price for the remaining energy that must be locally produced. Fortunately, all wholesale markets in the United States have what are called local market power mitigation mechanisms for limiting the bids of suppliers when these system conditions arise. However, like all forms of regulatory intervention, these local market power mitigation mechanisms are less than perfect and create additional market inefficiencies that consumers must pay for.

The ultimate solution to this problem is to construct the economically reliable transmission network described above. It is important to emphasize that such a transmission network will not eliminate transmission congestion. It will only eliminate

the ability of suppliers to withhold output to cause congestion so that they become a local monopolist or duopolist and therefore are able to raise the wholesale price they receive significantly through their unilateral actions.

## Overcoming Initial Conditions from the Vertically Integrated Regime

Another important rationale for transmission upgrades during the transition to a formal wholesale electricity market is to ensure that all consumers, regardless of their location in the transmission network, receive a share of the benefits from this new industry structure. Specifically, operating a wholesale electricity market using a transmission network built by the former vertically integrated utility can impose enormous economic burden on certain groups of consumers through no fault of their own, while at the same time allowing other consumers to realize significant benefits.

The former vertically integrated utility had a strong incentive to build a transmission network and locate generation units to minimize the total cost of meeting all demand in its service territory. This incentive implies that the utility might install a small high-cost generation unit in an area rather than upgrade the transmission network into that region because this was the least cost way for the utility to meet an annual increase in demand in an isolated portion of its service territory.

However, in a wholesale market regime, where each consumer pays the wholesale price of energy at their location in the transmission network, consumers located in this isolated geographic area will pay a price for all of their consumption set by this high-cost unit. In the former vertically integrated regime, the cost of operating this unit was averaged over all of the electricity sold by the vertically integrated utility and included in the price all consumers were charged for electricity.

Although all consumers should pay the market price of energy at their location in the transmission network, it is important to emphasize that the reason some consumers pay much higher prices in a wholesale market regime is because the existing transmission network was designed to serve the vertically integrated utility regime. The network was not built to facilitate a competitive wholesale market at all locations in the transmission network, but instead to minimize the overall costs of meeting the vertically integrated utility's retail load obligations.

Consequently, another argument for transmission upgrades is to limit the magnitude of inequities in the allocation of systemwide wholesale energy purchase costs to consumers due to the past transmission and generation investment decisions by the vertically integrated utility. Those consumers facing extremely high local energy costs because of the transmission and generation investment decisions of the former vertically integrated utility should receive transmission upgrades to increase their access to lower cost distant suppliers, and therefore share in the benefits of wholesale electricity competition.

## Current Trends in Transmission Investments

Despite these two rationales for additional transmission capacity in a wholesale market regime, total annual transmission investments in the United States over the past decade have declined continuously. Eric Hirst estimates that from 1975 to 1998 transmission investment in the United States fell by an average of 115 million 1997 dollars per year, from slightly more than 5 billion 1997 dollars in 1975 to slightly more than 2.5 billion 1997 dollars in 1998.<sup>1</sup> Hirst also reports that only one out of the ten National Electricity Reliability Council (NERC) regions did not experience at least a double-digit percentage decline in the ratio of megawatt-miles of transmission capacity divided by megawatts of peak demand over the period 1989 to 1998.

The pressing need for additional transmission capacity in a wholesale market regime and the dramatic slowdown in transmission investment over the past 25 years helps explain why the East Coast blackout of August 14, 2003 occurred. These two facts also suggest that similar blackouts may occur in other parts of the country making the transition to wholesale electricity markets unless significantly more transmission capacity is constructed to facilitate greater competition among wholesale electricity suppliers in these regions.

## Building Economically Reliable Transmission Networks

The national transmission network must be dramatically expanded, just as the United States expanded its transportation network to facilitate the enormous growth in interstate commerce during the 20th century.

In 1919, then Lt. Col. Dwight D. Eisenhower took part in the U.S. Army's first transcontinental motor convoy from Washington, D.C., to San Francisco. After 62 days on the road and numerous mishaps because of, among other things, poor road conditions, the convoy reached San Francisco. Eisenhower also observed that Germany had enjoyed many tactical advantages during World War II because of its autobahn network. These experiences caused him to see the need for a national transportation network.

The Eisenhower Interstate Highway System was constructed at a cost of 330 billion 1996 dollars. It is hard to argue that its existence has not generated many times that much in economic benefits in increased gains from trade because it allows the rapid transportation of goods and services throughout the United States at very low cost. By the same logic, the cost of upgrading the U.S. transmission network should be more than paid for by the economic benefits to consumers produced by more competitive wholesale electricity markets.

Unfortunately, electricity industry restructuring has effectively severed the incentive to undertake transmission upgrades from the ability to do so. Generation-unit owners profiting from congestion, as described earlier, have no incentive to support the upgrade. Electricity retailers bundle these congestion charges into their cost of purchasing wholesale electricity. Transmission owners receive a regulated rate of return on their network investments. Only consumers would like economically beneficial upgrades to occur, but individually they have little incentive to participate in the process.

Like the interstate highway system, an improved transmission system begins with the federal government. Only a concerted national policy can ensure sufficient transmission capacity across state boundaries to establish competitive interstate markets for electricity. States also have a major role to play by ensuring that the networks within their boundaries are adequate to ensure effective competition among suppliers.

Taking the example of California, the revenues that result from raising transmission charges by 0.1 cent per kilowatt-hour could easily fund enough transmission upgrades to produce a far more competitive wholesale market throughout the West. For a household consuming 800 kilowatt-hours per month, this would raise the monthly bill by 80 cents. Average retail prices could ultimately fall as a result of these upgrades because of the increased competition and lower wholesale electricity prices facilitated by these upgrades.

Constructing such an economically reliable transmission network does not require a revolutionary change in federal or state regulatory policies. State public utilities commissions must first understand the above logic underlying the need for more transmission capacity in a wholesale market regime. Both state and federal regulators must take a very proactive role in identifying beneficial upgrades and providing the appropriate financial incentives to transmission owners to get them built.

Cost/benefit calculations that account for the competition-enhancing benefits of transmission upgrades should be taking place at state public utilities commissions throughout the United States in order to deliver the full benefits of electricity restructuring to consumers. Federal involvement is essential to ensure that transmission upgrades that enhance interstate wholesale competition are identified and built.

The funding of the interstate highway network provides a valuable lesson for how to fund an economically reliable nationwide transmission network. A major stumbling block with passing interstate legislation was financing. Initially, the federal-state cost-sharing ratio was to be 60:40. Ultimately, the bill that passed had a 90:10 federal-state sharing rule. Given the highly integrated nature of most regional electricity markets, this regional-state or federal-state sharing rule seems representative of the likely distribution of benefits to a large regional or even a national transmission network.

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<sup>1</sup>Hirst, Eric, "Expanding U.S. Transmission Capacity," Report Prepared for Edison Electric Institute, Washington, D.C., July 2000.

## About the Author

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