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The Latest Market Data Show that the Potential Savings of New Electric Transmission was Higher Last Year than at Any Point in the Last Decade

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In 2022, additional transmission could have reduced electric system costs by more than in any year from 2012 through 2021. Generally high electricity prices coupled with extreme weather events and other factors helped drive the high value for transmission. Transmission congestion-relief values were high in many regions in 2022, with a number of interregional links reaching $200 to $300 million per 1000 MW of transmission capacity (or $23 to $34 per MWh). Additionally, wholesale pricing patterns during winter storm Elliott at the end of 2022 illustrate the role of transmission in helping manage periods of grid stress. In this factsheet, we analyze the latest data and describe what energy pricing patterns tell us about the state of the U.S. power market and the possible value of additional transmission infrastructure.

Introduction

We build on our past research, focusing on locational price arbitrage as one signal of the value of transmission expansion. The difference in wholesale electricity prices between two locations largely represents the cost of congestion or, conversely, a key potential value of new transmission. While the congestion-based value of transmission analyzed here represents one of the largest sources of transmission value, transmission provides other benefits that we do not measure (including, for example, reliability, resiliency, and emission-reduction benefits). Underlying the congestion-based transmission benefits that are the focus of this factsheet is the simple concept that transmission enables a lower cost set of generators to meet load than would otherwise be available.

Our prior work focused on the period 2012-2021 and concluded that existing transmission planning approaches run the risk of understating the economic value of new transmission. We found that wholesale power prices exhibit stark geographic differences and that increased transmission across many regional and interregional transmission links would have substantial economic value. We further found that transmission congestion value varies by year and is correlated with the national average of wholesale electricity prices. Extreme conditions and high-value periods have an outsized role in driving this value, though named extreme weather events oftentimes do not play as large a role as more-normal, but infrequent conditions, such as infrastructure outages or demand forecast misses. Data from 2022 largely confirm and strengthen these findings. Additionally, wholesale pricing patterns during winter storm Elliott at the end of 2022 illustrate the role of transmission in helping manage periods of grid stress.

Key Findings

High transmission value (or equivalently, cost savings) existed in most regions in 2022. We calculate two metrics of the potential price-arbitrage value of transmission across a set of 64 location pairs (Figure 1). The first metric represents the average hourly price spread in 2022 across each pair of locations and ranged between $3/MWh and $58/MWh (top image). The second metric represents the 2022 value of a hypothetical 1000 MW line connecting the two locations and ranged from $29 million to $505 million per year (bottom image). Most, but not all, links with an annual value above $200 million per 1000 MW were interregional links. However, many regional links had 2022 values between $100 and $200 million per 1000 MW. These estimates are based on location specific marginal energy prices only, and thus represent a marginal value calculation; additional context and limitations are described at the end of this factsheet.

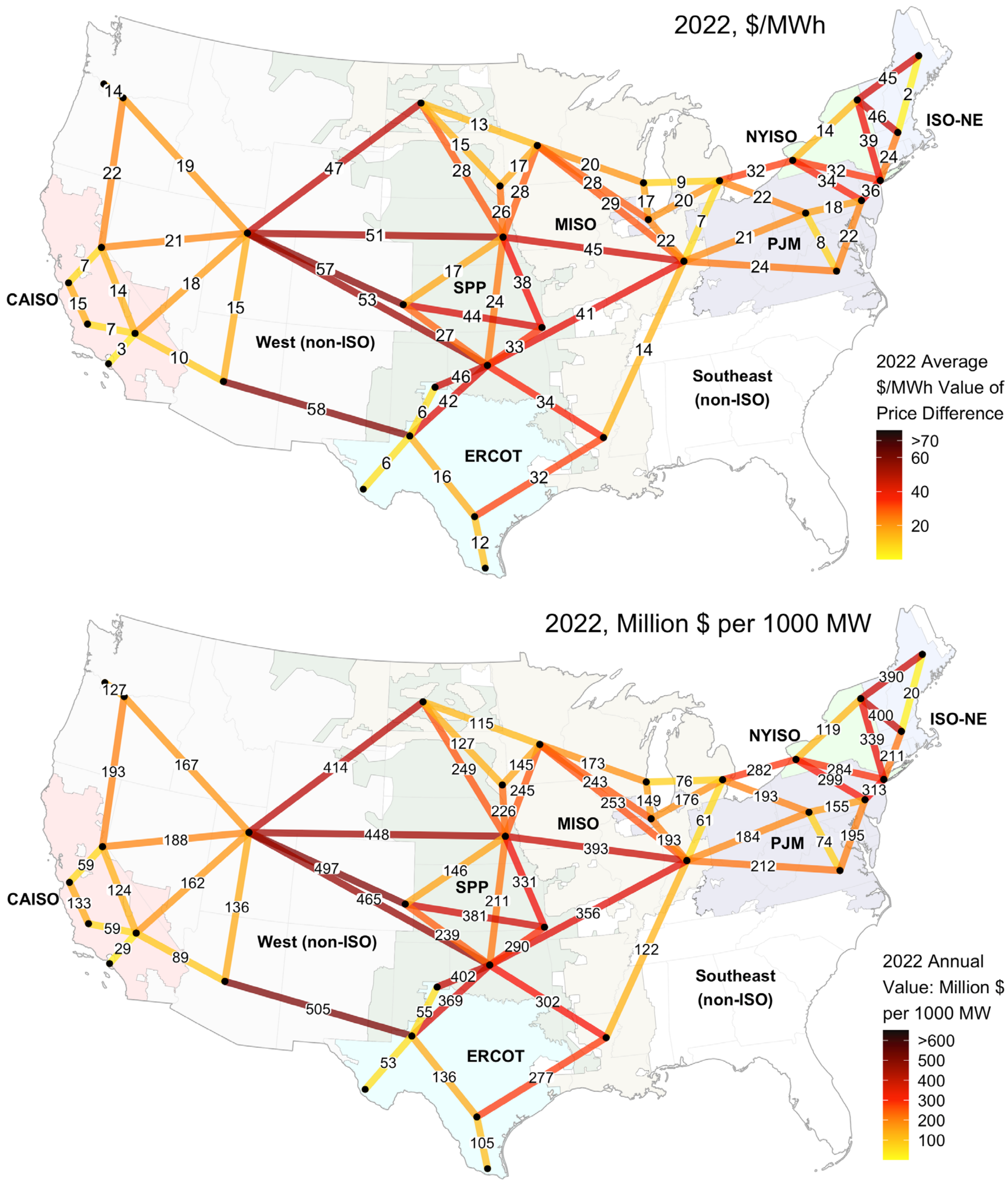

Figure 1. High transmission value is observed in many regions in 2022.
Top panel: The average absolute value of the hourly difference in prices across each link. Bottom panel: the annual cumulative value of a hypothetical 1000 MW transmission link. These values are marginal (applying to the next unit of transmission) and based only on hourly energy price arbitrage. Note that we were unable to analyze transmission value where pricing data was limited or not available, for example in the non-ISO Southeast region.

Transmission value was higher last year than at any point in the last decade. Across the set of 64 links the mean value was $220 million per 1000 MW (or $25/MWh) and the median value was $193 million per 1000 MW (or $22/MWh). Compared to previous years studied (2012 – 2021), both the mean and the median value of links reached new heights in 2022 (Figure 2).

The median and mean price differences across different years (left and right of Figure 2, respectively) provide insight into the geographic scale of events causing high transmission values. The median value was significantly higher in 2022 than any other year, indicating that the increase in transmission value last year was a broad phenomenon across most of the U.S. and not specific to any one region. The increase in transmission value across so many locations is suggestive of a cause that is national in nature, such as increased average energy prices in 2022. In contrast, high mean values without corresponding high median values (such as in 2018 and 2021) indicate that certain events can drive extremely high transmission value in isolated regions. In 2021, for example, winter storm Uri drove high values for interregional transmission into SPP and ERCOT, but had less impact on other regions of the U.S.

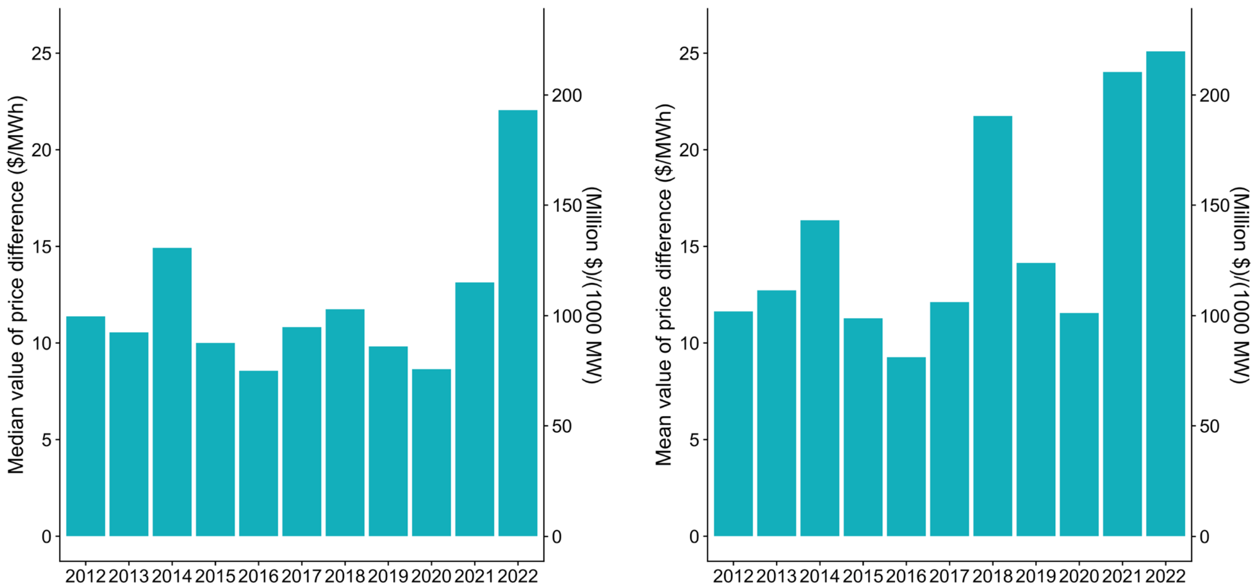

Figure 2. Transmission value was higher in 2022 than in past years in the study period.
Median (left) and mean (right) value of transmission links across the set of 64 links. Note that the set of links in the early years is smaller due to data constraints.

Transmission value was concentrated in a small portion of total hours. This was true in past years as well as in 2022. For the typical link in 2022 (calculated as the median value across the 64 links), 50% of total value was derived from only 10% of the hours, and 37% of total value was derived from only 5% of the hours (Figure 3). Compared to past years, value was slightly less concentrated in time. For example, from 2012 – 2021, a typical link derived 50% of value from only 5% of hours (not 10% as in 2022). The finding that value was less concentrated in time in 2022 is also consistent with generally higher wholesale electricity prices leading to higher values across all hours. Higher average prices increase transmission values because price volatility and spatial differences in price tend to increase with average prices.

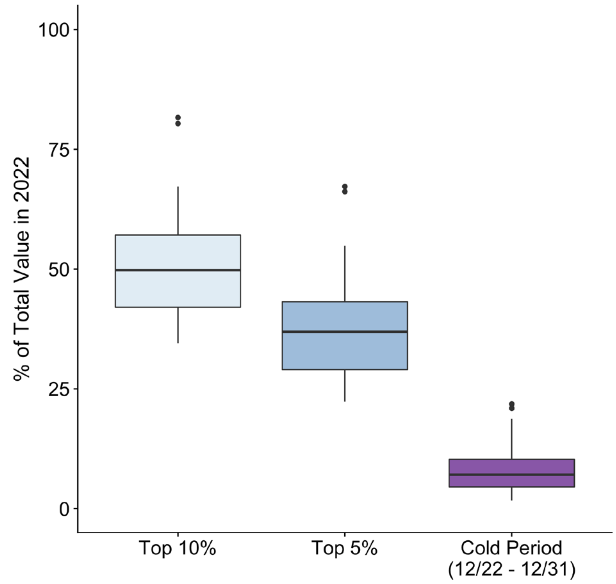

Figure 3. Transmission value was concentrated in a small fraction of total hours.
The most valuable 5% and 10% of hours accounted for a substantial portion of total annual transmission value as shown above. The box and whisker format shows the spread of the data across the full set of 64 links in the study.

Wholesale pricing patterns during winter storm Elliott illustrate the role of transmission in helping manage periods of grid stress. During the final week of 2022, in which this storm gripped the country, the typical link derived 7% of its total annual value (Figure 3). However, total annual value was more closely tied to the storm in certain regions. Figure 4 shows the percentage of annual value for each link derived from winter storm Elliott. The storm boosted transmission values in MISO, PJM, and the Northeast, such that for many links in these regions this short period provided 10% to 22% of total annual value.

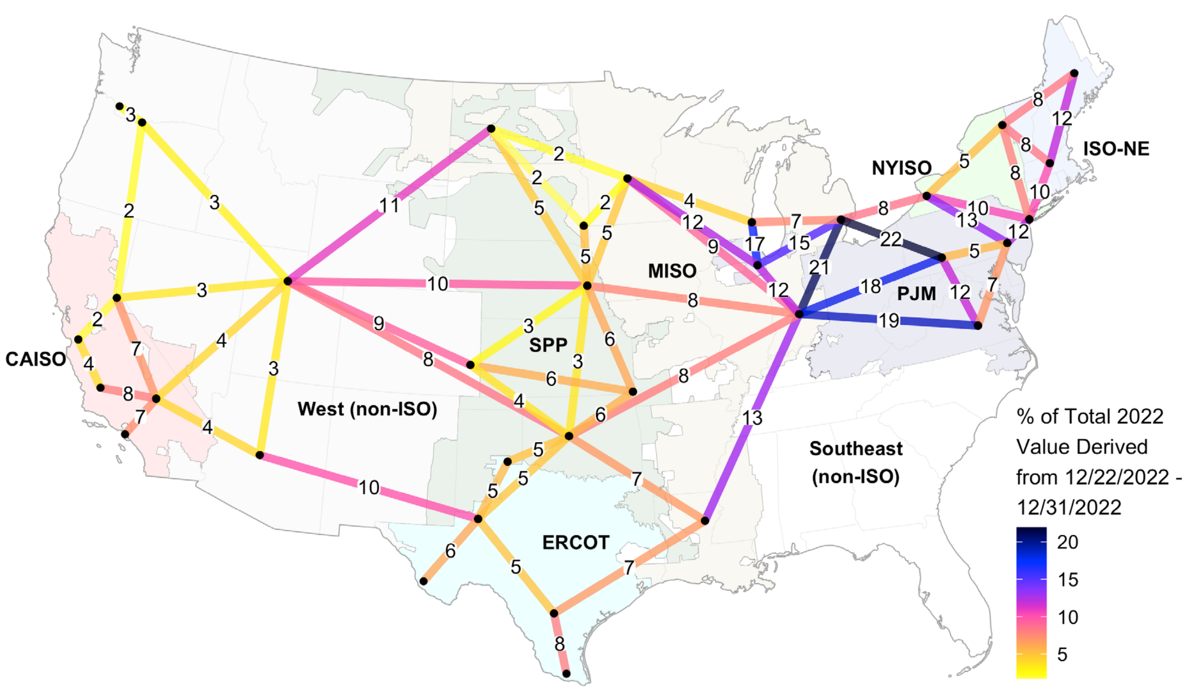

Figure 4. Winter storm Elliott provided a substantial portion of total transmission value in some regions of the country.
The value from this event illustrates the role of transmission in managing the economic and physical risks of such incidences.

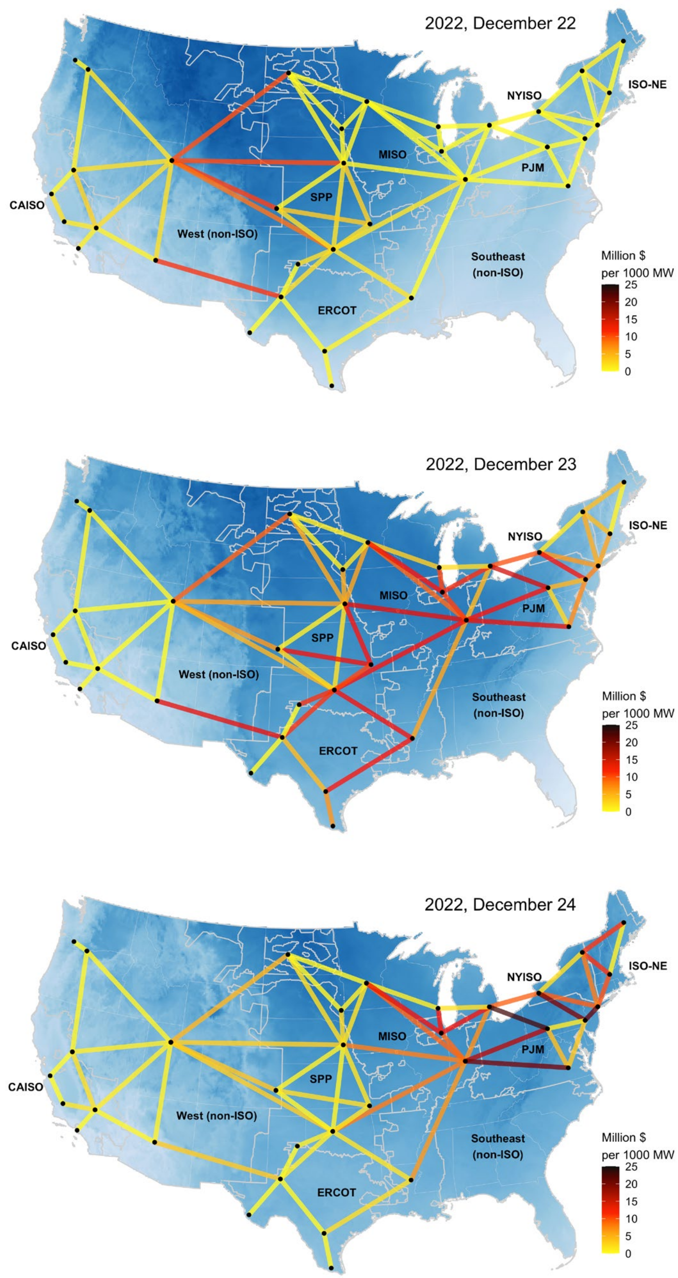

Figure 5. Transmission value moved east with cold surface temperatures December 22nd – 24th. *The value shown above is calculated as a total for each day (central time). Darker blue colors indicate colder surface temperatures.*

The cold weather associated with winter storm Elliot moved first south through the Midwest and then eastward. Transmission value largely followed this path with the highest value links pointing into the center of the storm and shifting over time (Figure 5). Most of the high value links highlighted in Figure 5 are interregional, showing the particular value of interregional links in helping to mitigate costs during extreme weather.

Transmission values in 2022 further illustrate the challenge assessing the full benefits of new grid infrastructure. Transmission congestion-relief values were unusually high in 2022. The value patterns demonstrate the sensitivity of transmission value to overall wholesale electricity prices (and thus to natural gas prices) and to rare events (weather, as identified, as well as the other 10% of high value hours that accounted for 50% of value). In as much as transmission planning studies do not adequately take into account uncertainties in weather, natural gas prices, and other factors, they may deeply understate the possible value of new transmission.

Key Limitations

Prices in wholesale energy markets represent the cost of the next unit of generation (i.e., they are marginal prices), and thus the transmission value metric we calculate represents the value of the next unit of transmission. What this means is that the transmission value is subject to saturation effects – i.e., as more transmission is added to the system the value of additional transmission would decline. When we calculated the value of new transmission with 1,000 MW of capacity we assumed that there were no saturation effects, and it is likely that in some locations our transmission value estimate would be more applicable to a smaller capacity addition than a full 1,000 MW. On the other hand, many of the locations chosen are 'hub' nodes, representing prices over a region, and thus may not be as sensitive to saturation effects as a more localized pocket of demand. For context, PJM load peaked at over 130,000 MW during December 23, 2022. An additional consideration is that some of the difference in prices between locations is due to electric line losses, though typically losses are much smaller than congestion costs. Also, some differences in prices between regions are due to market structure and agreements rather than true lack of transmission capacity; these structural costs are also generally small compared to potential value of added transmission. Finally, the value calculated here only represents a small portion of total transmission value (it does not include reliability, resiliency, and emission benefits). The transmission value calculated here is most similar to 'production cost' benefits, which have been found to account for roughly half of total transmission value in a number of 'multi-value' transmission studies. Finally, understanding both value and costs are critical to planning for new transmission, our research here aims to inform transmission value estimates, but it does not address transmission cost estimates.

Conclusions

This study finds that additional regional and interregional transmission would have had significant economic value in 2022, larger than any year 2012 – 2021. This update for year 2022 supports past results that indicated many existing transmission planning approaches are likely understating the economic value of new transmission infrastructure. In part, this is because roughly half of the marginal value of transmission in providing congestion relief occurs during extreme grid conditions and high-value periods that are not always adequately modeled or considered by transmission planners. These periods are natural features of actual market operations. As such, this and our earlier study highlights the need for planners to more-comprehensively assess the value of transmission under both normal and extreme conditions. We plan to produce more in depth research on these topics later this year. Stay tuned!

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