Transmission Value Assessment based on Energy Market Prices

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$$\text{Marginal Value Metric} = \frac{1}{n} \sum_{t=1}^{n} \left| price_t^A - price_t^B \right|$$

Simple in concept but leads to a host of interesting conclusions…

Notes:

- Can calculate this with real time or day ahead locational marginal prices (LMPs)
- Hub-nodes or zonal nodes ensure we are assessing larger market areas
- This value metric is *a subset* of transmission value
- *Not* equal to production cost value
- Assumption: Frictionless transfer of energy from low price node to high price node
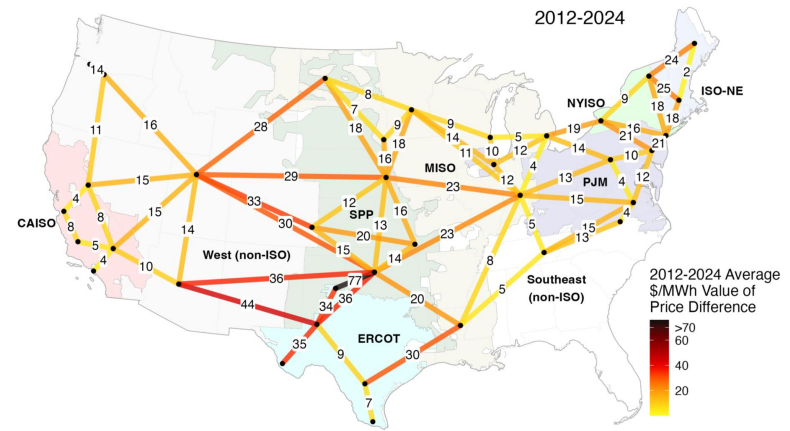- No AC complications considered

2012 - 2024

2012-2024 Average $/MWh Value of Price Difference
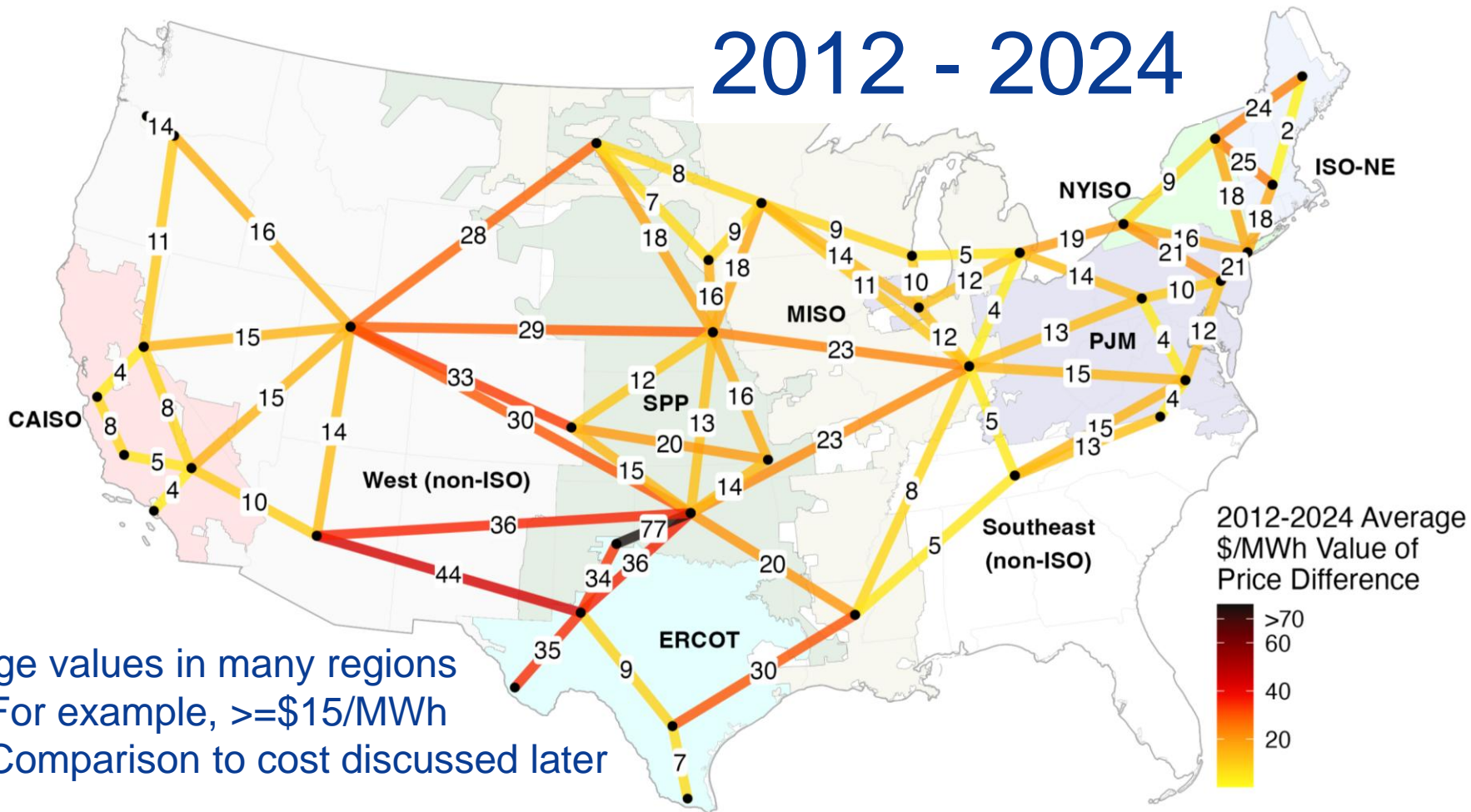
Large values in many regions
- For example, >=$15/MWh
- Comparison to cost discussed later

Note: Some links have data only back to 2015
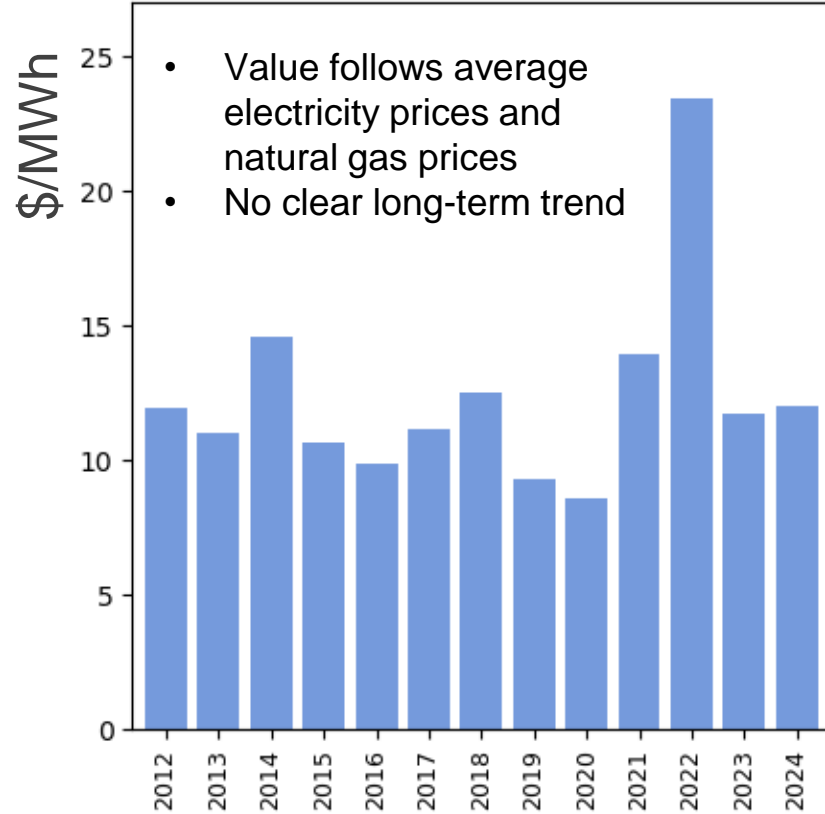
Exploring transmission value:

1. When and where is transmission valuable?
2. What drives transmission value?
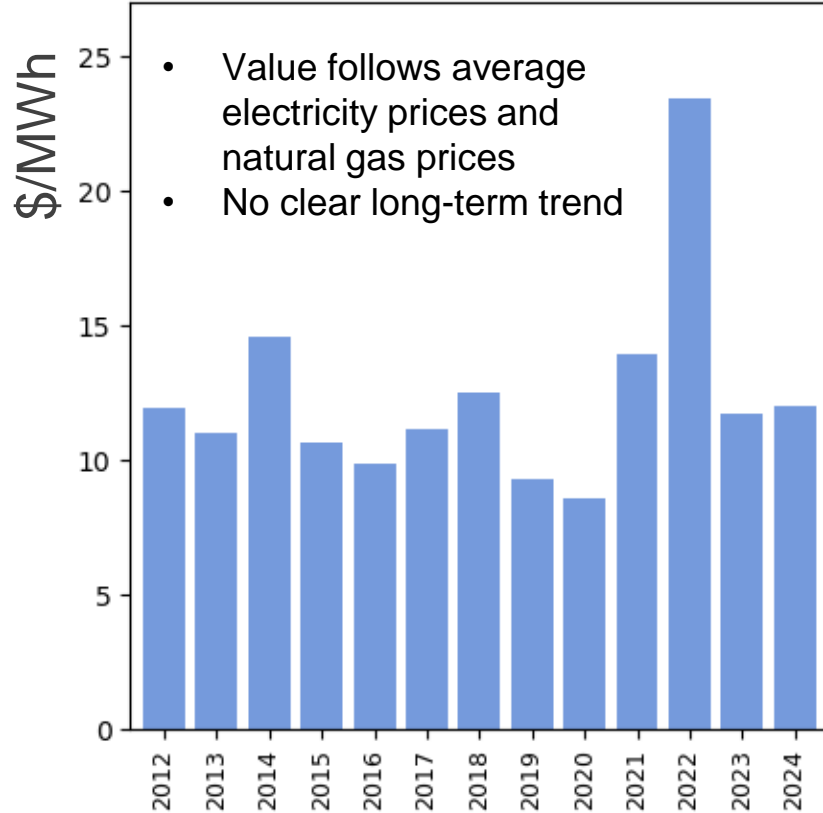3. Beyond marginal value, comparisons to costs
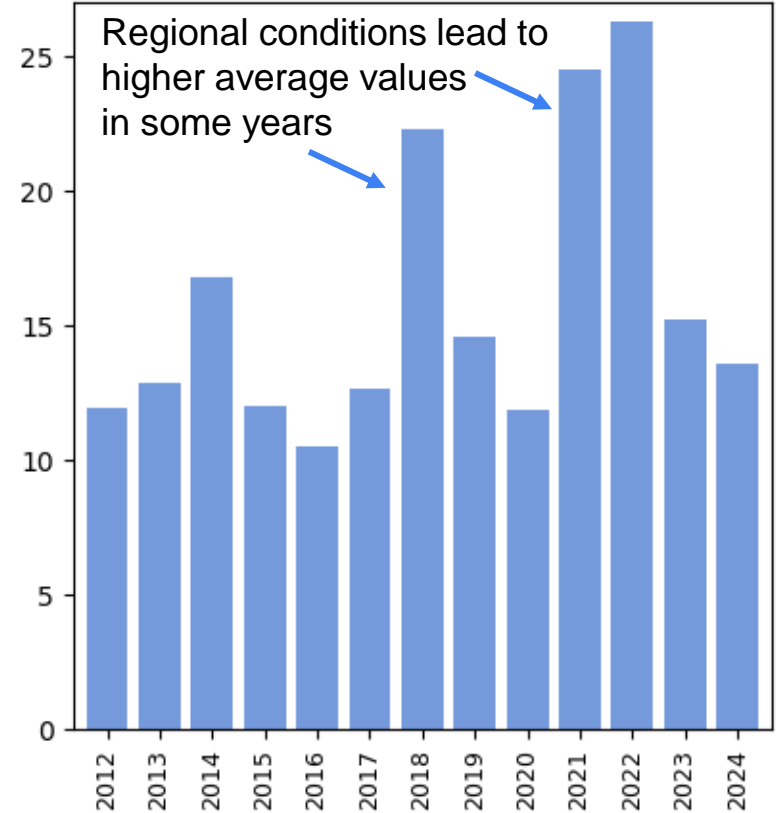
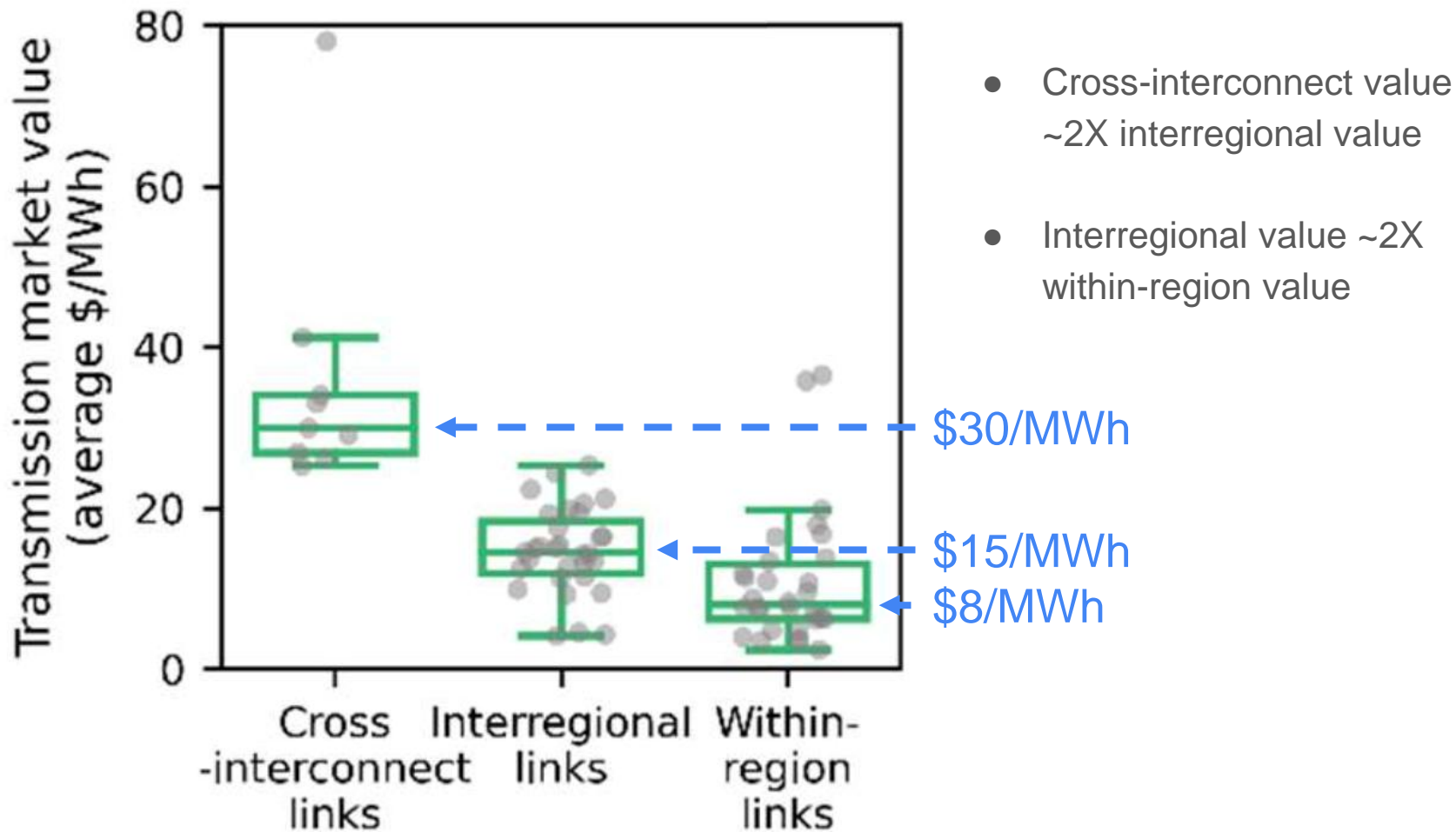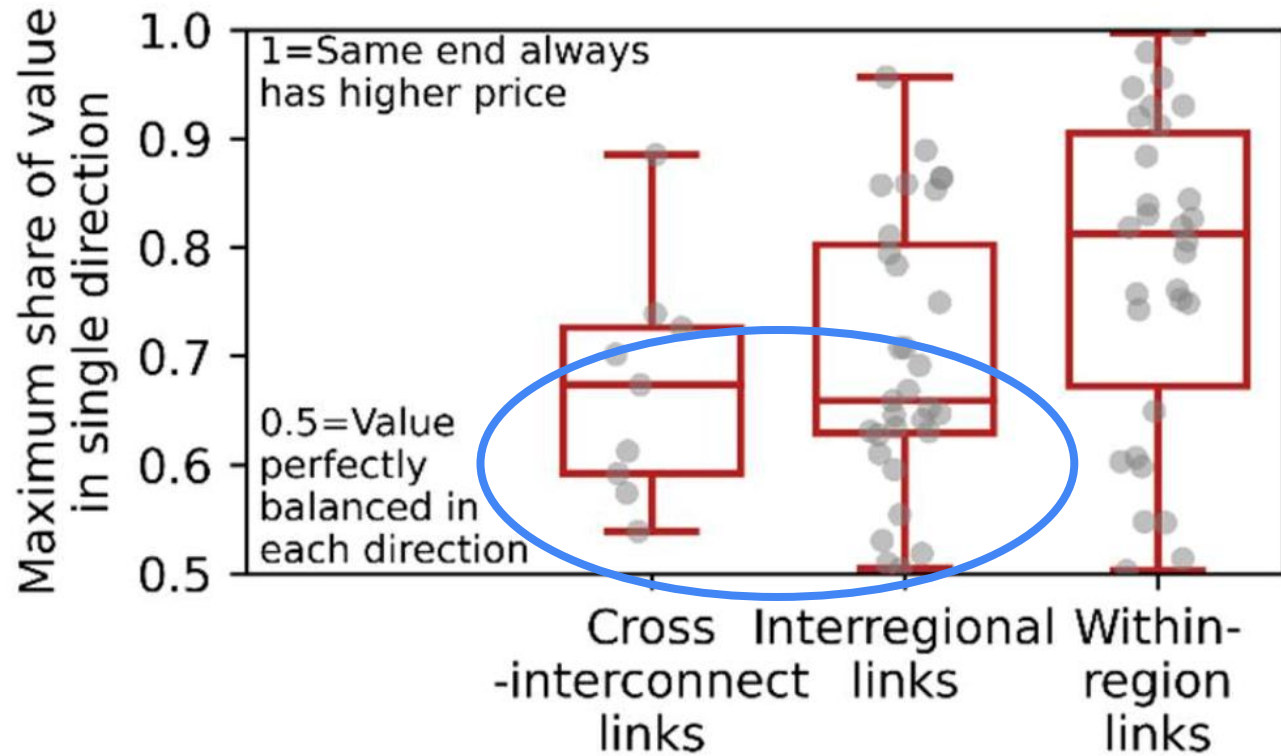# When and where is transmission valuable?

Median Value

$/MWh

- Value follows average electricity prices and natural gas prices
- No clear long-term trend

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Average Value

Regional conditions lead to higher average values in some years

- Cross-interconnect value ~2X interregional value

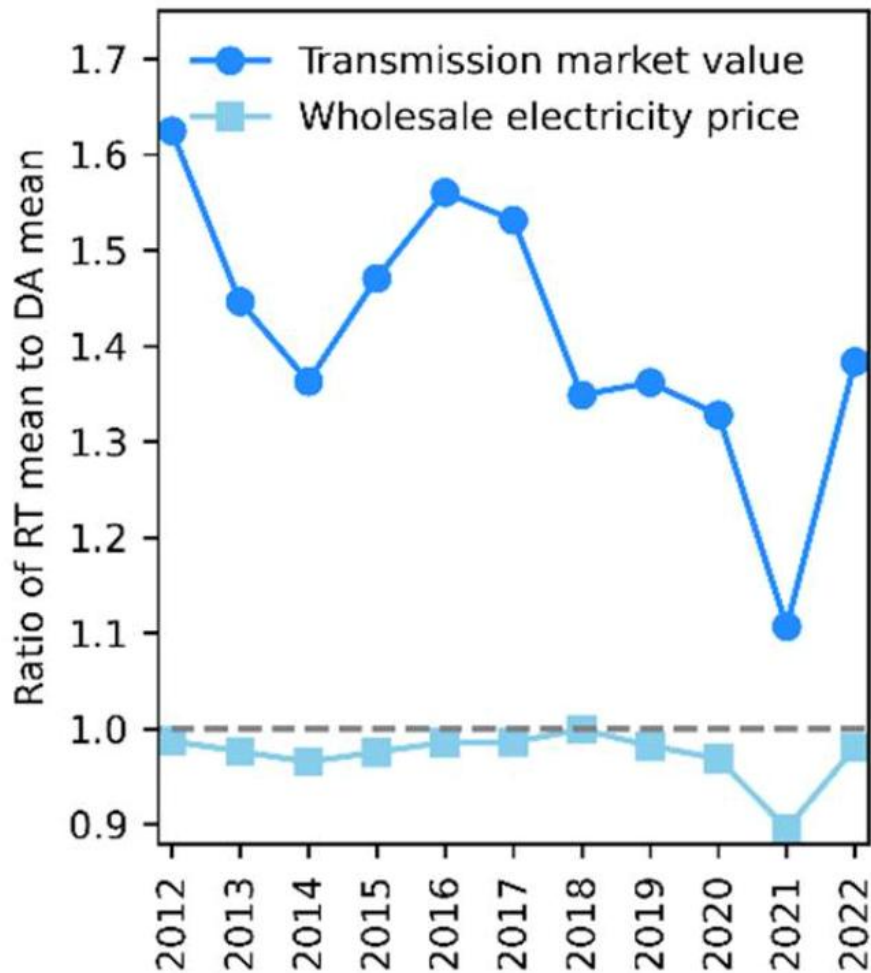- Interregional value ~2X within-region value

- Cross-interconnect and interregional links often directionally balanced
  - That is, both sides of the link experience high prices at separate times from each other
  - Median balance for those categories is ~0.65
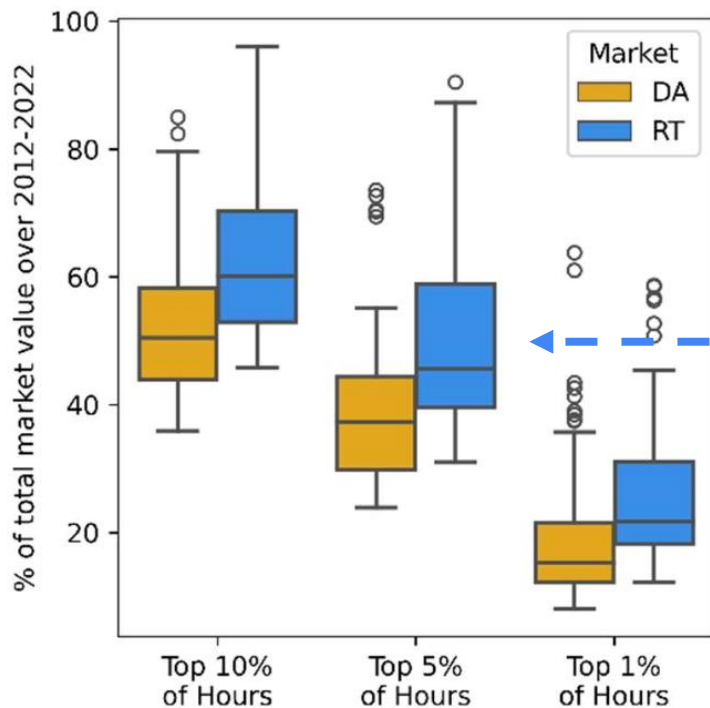
What drives high transmission value?

Transmission value:
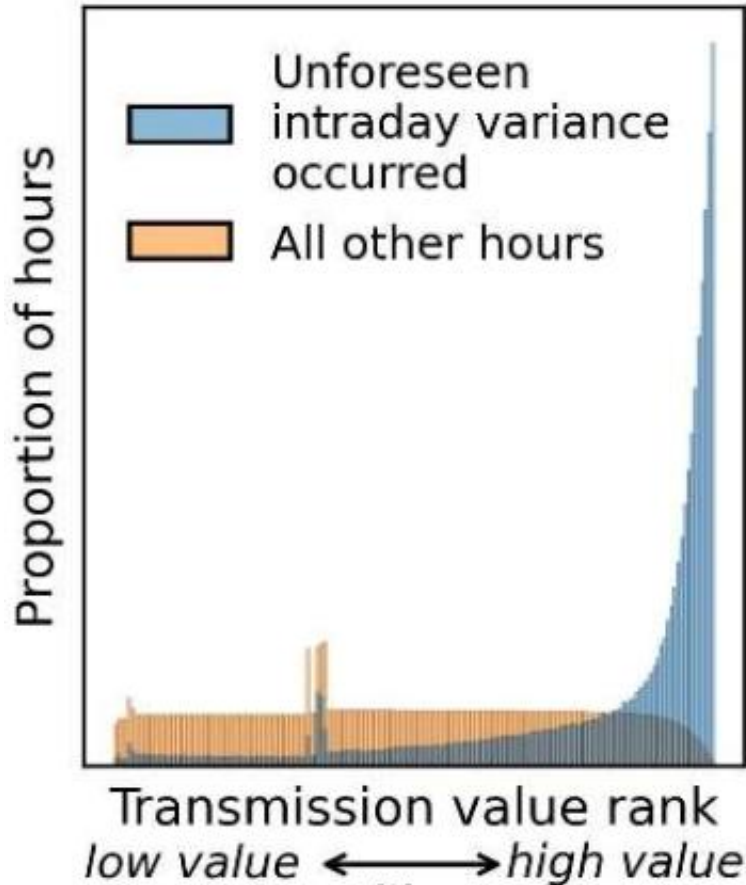Real-time value > day-ahead value

Electricity prices:
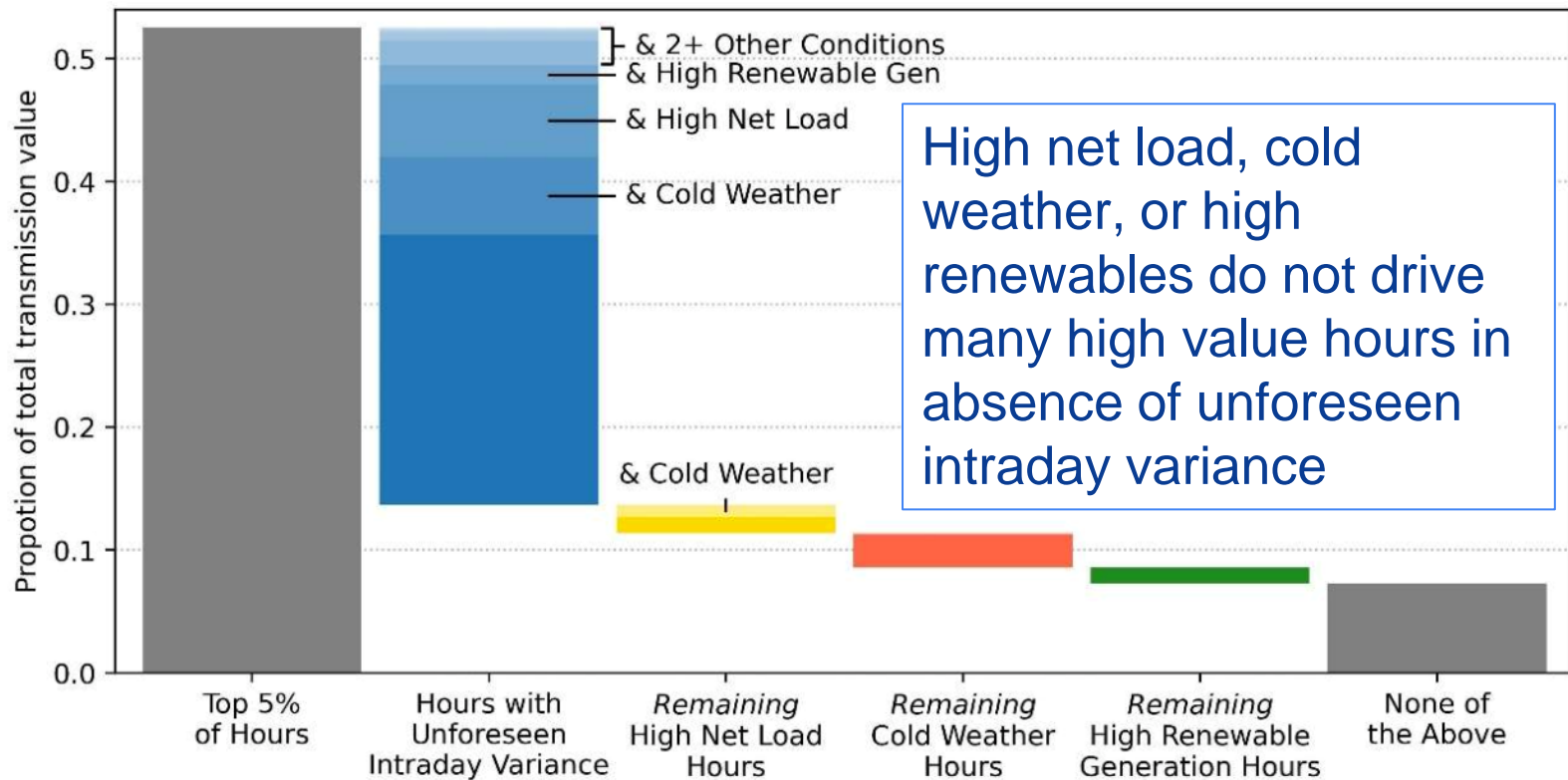Real-time prices are slightly lower than day ahead prices

Real time value is concentrated in time: ~50% of value derives from 5% of hours

Day-ahead value is also concentrated in time, but not as concentrated: ~40% of value in top 5% of hours

Unforeseen intraday variance = A large change in the LMPs between the day-ahead and real-time markets on either side of a link

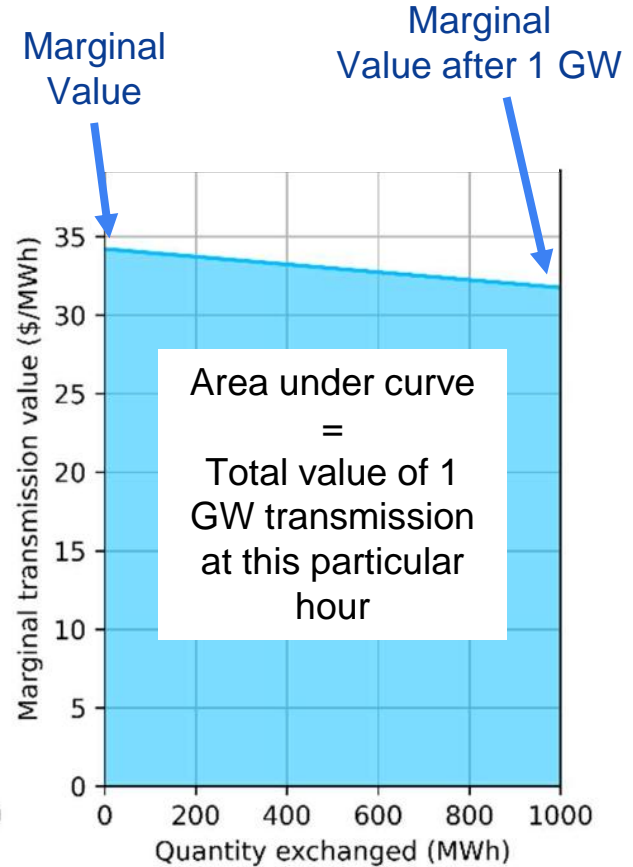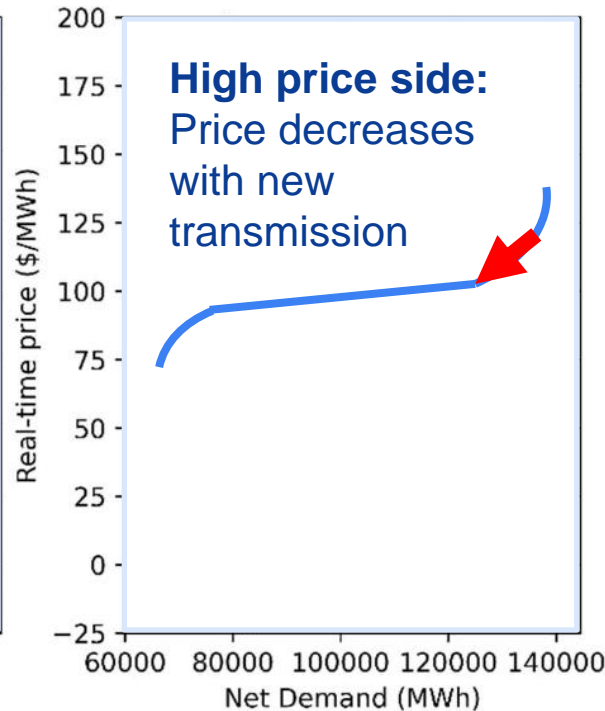**The highest value hours for transmission are associated with unforeseen intraday variance**

High net load, cold weather, or high renewables do not drive many high value hours in absence of unforeseen intraday variance
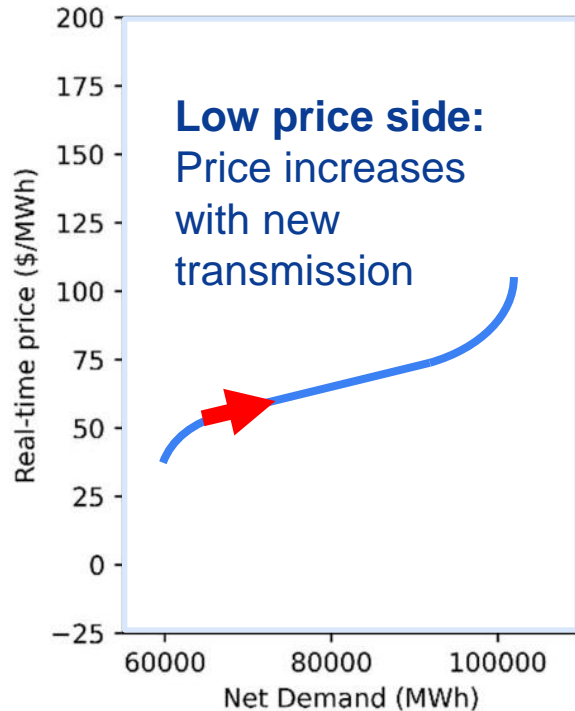
Key conclusions so far

- **When and where is transmission valuable?**
  - Highest value for cross-interconnect and interregional links
  - Value varies annually with average prices, no evidence for long term trend

- **What drives transmission value?**
  - A small portion of high value hours (5% of hours ~ 50% of value)
  - High value periods are associated with unforeseen intraday variance
  - Other conditions such as high net load, cold weather, or high renewables rarely drive high transmission value periods unless they are combined with some unexpected variance occurring

Beyond marginal value, comparisons to costs

- We use empirical supply curves to estimate marginal price convergence with additional transmission

Low price side: Price increases with new transmission

High price side: Price decreases with new transmission

Marginal Value

Marginal Value after 1 GW

Area under curve = Total value of 1 GW transmission at this particular hour
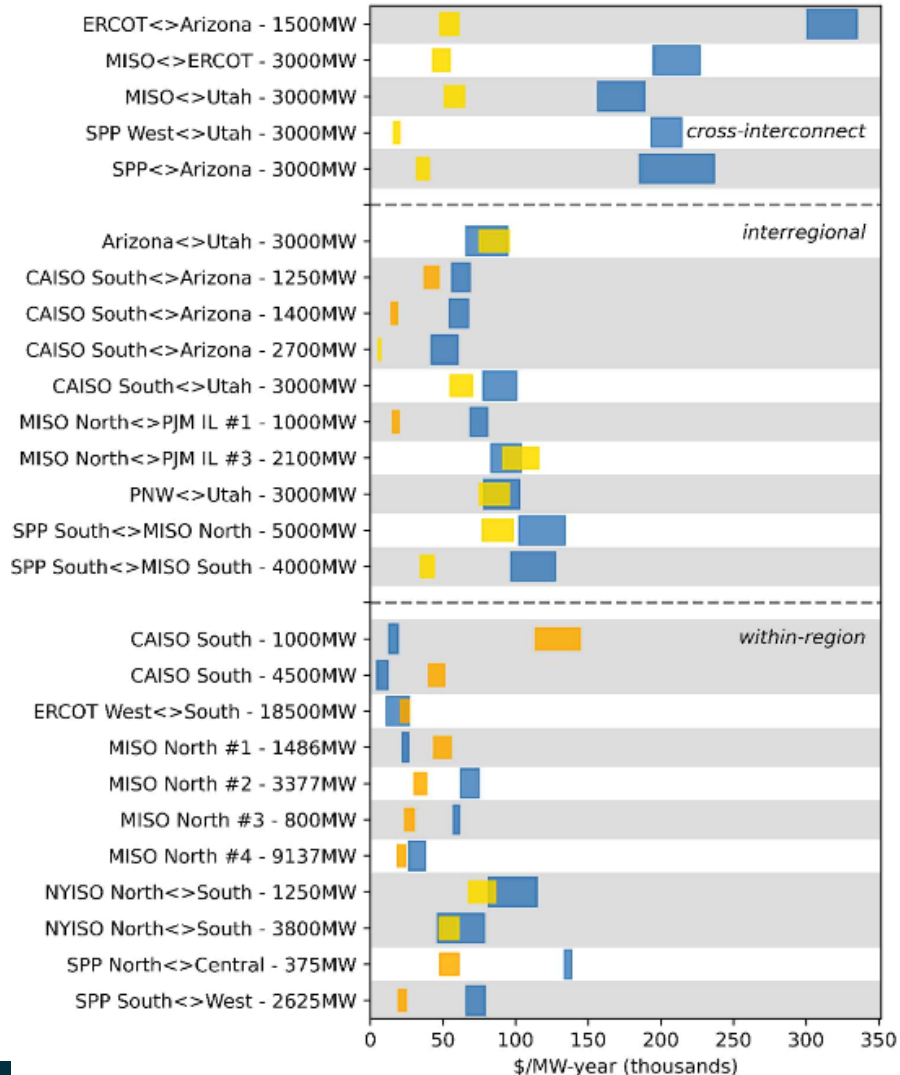
- Example shown for MISO <-> PJM, 2014-06-16
- Supply curves built based two-week periods
- Outlier points treated with a bounding approach
  - See details in forthcoming paper, Kemp et al. "Electric transmission value and its drivers in United States power markets"
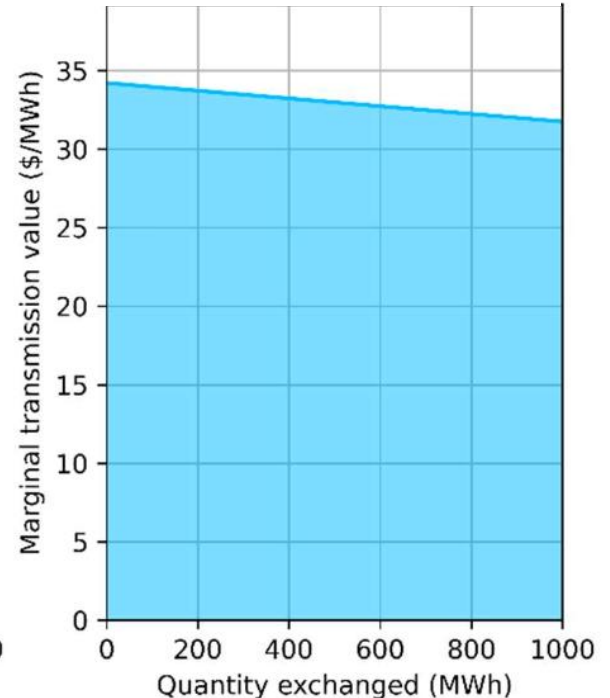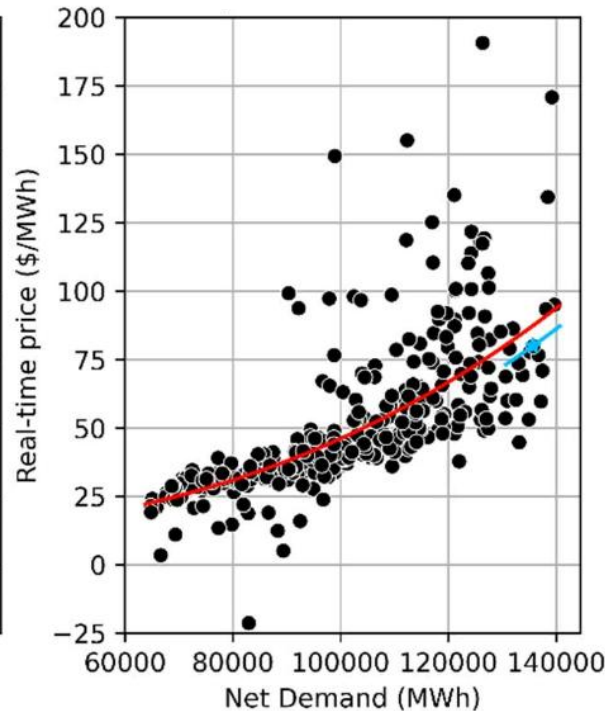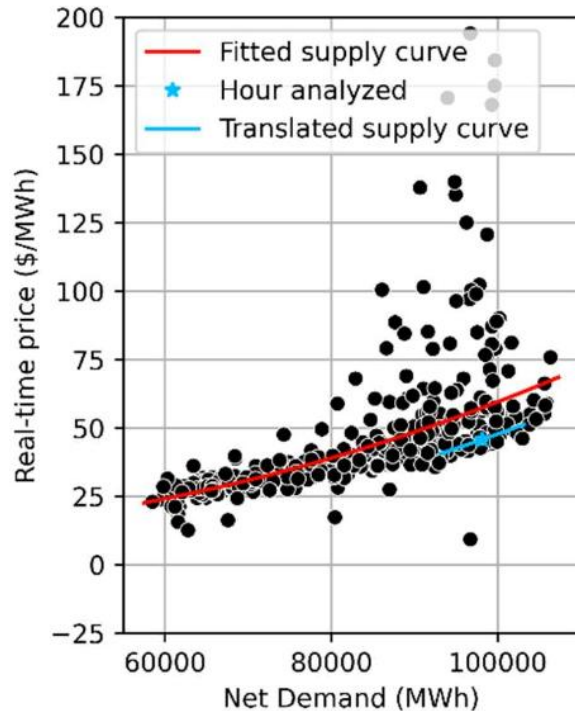
With 1 GW of transfer capability, total value ~ 80% of original marginal value
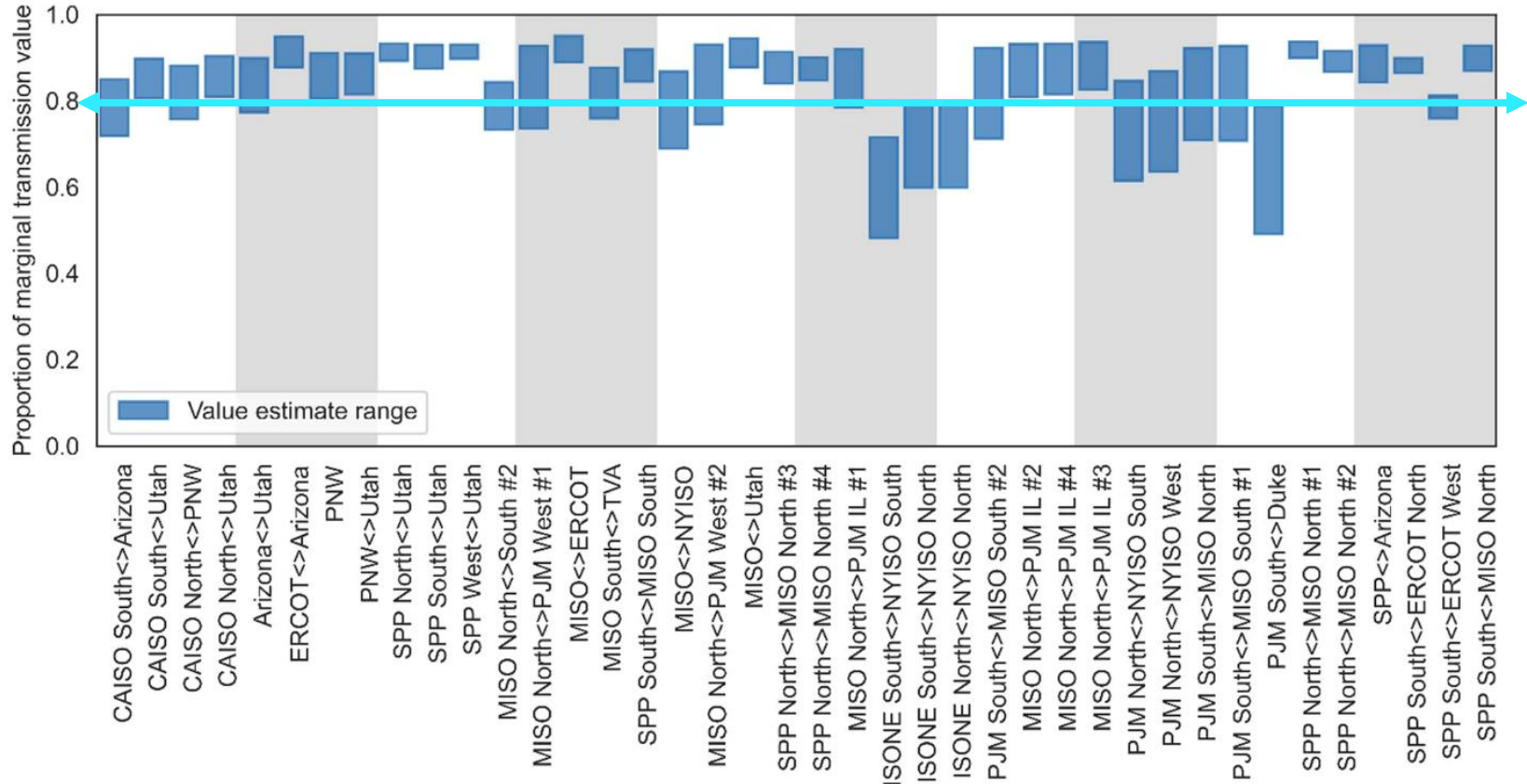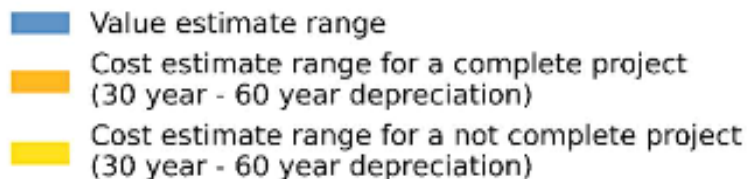
**Cross-interconnect value estimates
3 – 10X larger than cost estimates**

**Interregional value estimates
1 – 5X larger than cost estimates**

**Within-region value estimates
0.2 – 5X cost estimates**

Value estimate range

Cost estimate range for a complete project
(30 year - 60 year depreciation)

Cost estimate range for a not complete project
(30 year - 60 year depreciation)

Conclusions

- Many transmission links have significant value as indicated by market prices
  - Not just marginal value, but total value after accounting for price convergence with new trade
- Interregional links (those crossing market or grid seams) are especially valuable
- Our scoping-level comparison of transmission costs to historical energy market values finds greater value than cost for majority of links, including *all cross-interconnect links*

- Ongoing research is exploring:
  - The causes of unforeseen intraday variance
  - More sophisticated empirical techniques to understand price convergence with new transmission
  - Electric system modeling techniques and their impact on transmission value estimates

Acknowledgements