Market Benefits and Seams: Options and Implications

PREPARED BY

Johannes Pfeifenberger
John Tsoukalis
Kai Van Horn

PRESENTED AT

Spring 2024 Joint
CREPC-WIRAB Meeting
Denver, CO

April 24, 2024

Brattle

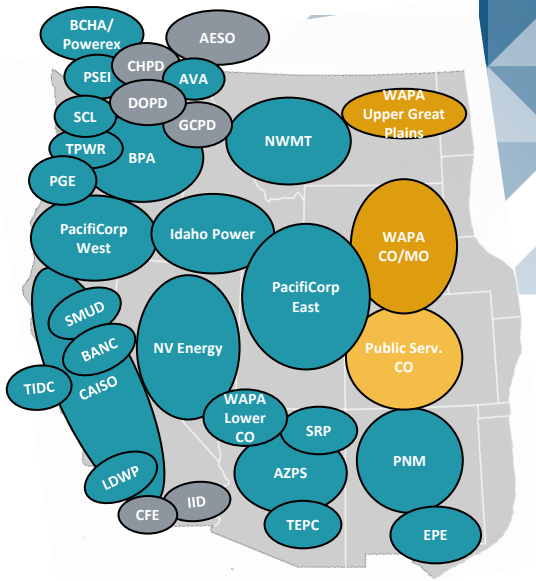
Brattle EDAM/Markets+ Benefits Analyses (for NVE)

Scenarios to capture range of potential footprints:

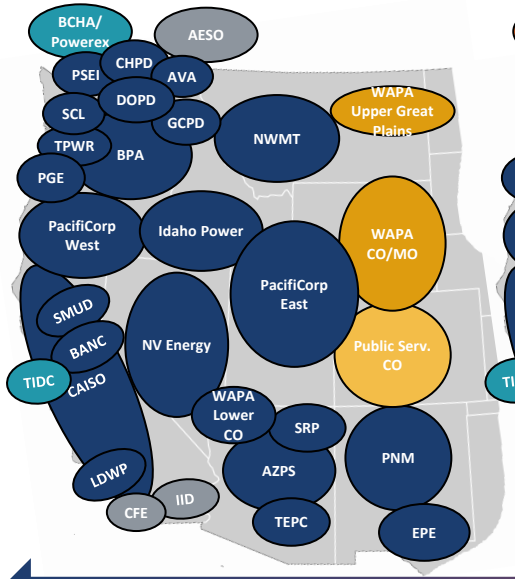
- Status Quo (BAU) vs. WEIM+EDAM vs. Markets+
- M+ assumed to have day-ahead and real-time markets
- RTO West co-optimized with M+ where applicable

SPP RTO West
WEIS only
Markets+
EDAM & WEIM
WEIM only
Non-Market BA

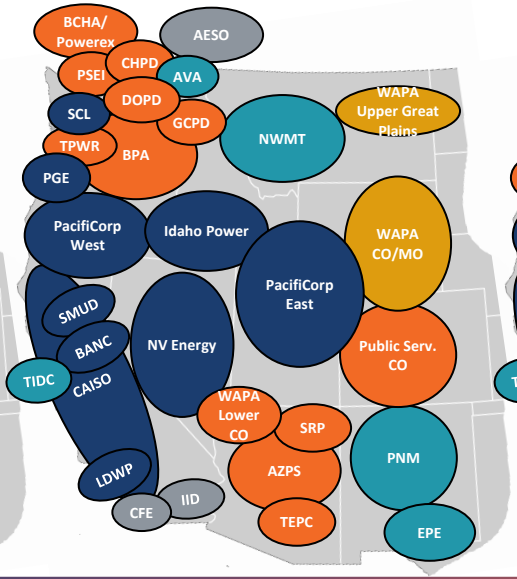
Status Quo (BAU)



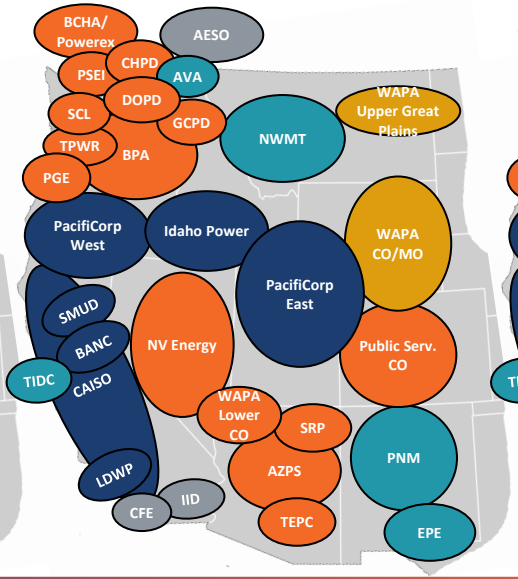
Bookend EDAM



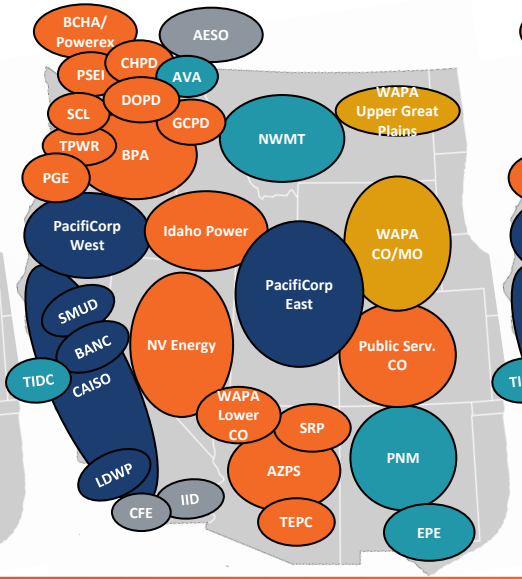
Middle View 1



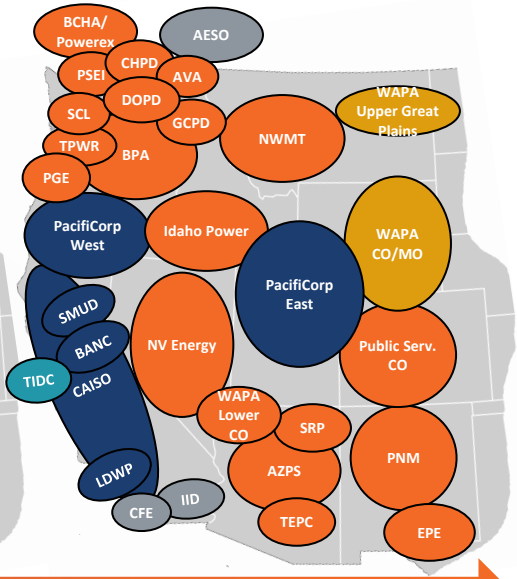
Middle View 2



Middle View 3



Bookend M+



NVE in EDAM | NVE in EDAM | NVE in M+ | NVE in M+ | NVE in M+

Bigger EDAM Footprint

Source: NV Energy Day-Ahead Market Benefits Studies

Bigger M+ Footprint

Markets offer Significant WECC-Wide Benefits

The implementation of M+ and/or EDAM produces significant WECC-wide customer benefits, with **estimated benefits ranging from $825-$985 million per year** across the footprint scenarios

- A single market covering most of the WECC (bookend EDAM in this case) produces the highest benefits
- A two-market EDAM/M+ scenario, even one with limited market transfer capability between the Pacific Northwest and the Southwest in the M+ footprint, produces only modestly lower benefits

(Note: the variation in benefits across scenarios will generally be larger for individual market participants)

WECC-Wide Benefits ($ Millions)

	BAU	Bookend EDAM	Middle View 1	Middle View 2	Middle View 3	Bookend Markets+
WECC-Wide						
Adjusted Production Cost	$10,273	$9,007	$9,880	$9,894	$9,919	$9,891
Wheeling Revenue	$446	$128	$378	$439	$434	$396
Trading Revenues:						
Bilateral	$1,327	$487	$506	$496	$477	$343
WEIM	$339	$263	$236	$192	$182	$99
WEIS/Mk+ RT Market	$28	$31	$89	$124	$125	$134
EDAM	-	$950	$946	$734	$676	$670
Markets+	-	-	$454	$606	$717	$945
Total System Cost	**$8,134**	**$7,149**	**$7,269**	**$7,303**	**$7,308**	**$7,304**
Benefit Compared to BAU		**$985**	**$865**	**$831**	**$826**	**$830**

All market participation scenarios show benefits relative to BAU

Source: NV Energy Day-Ahead Market Benefits Studies

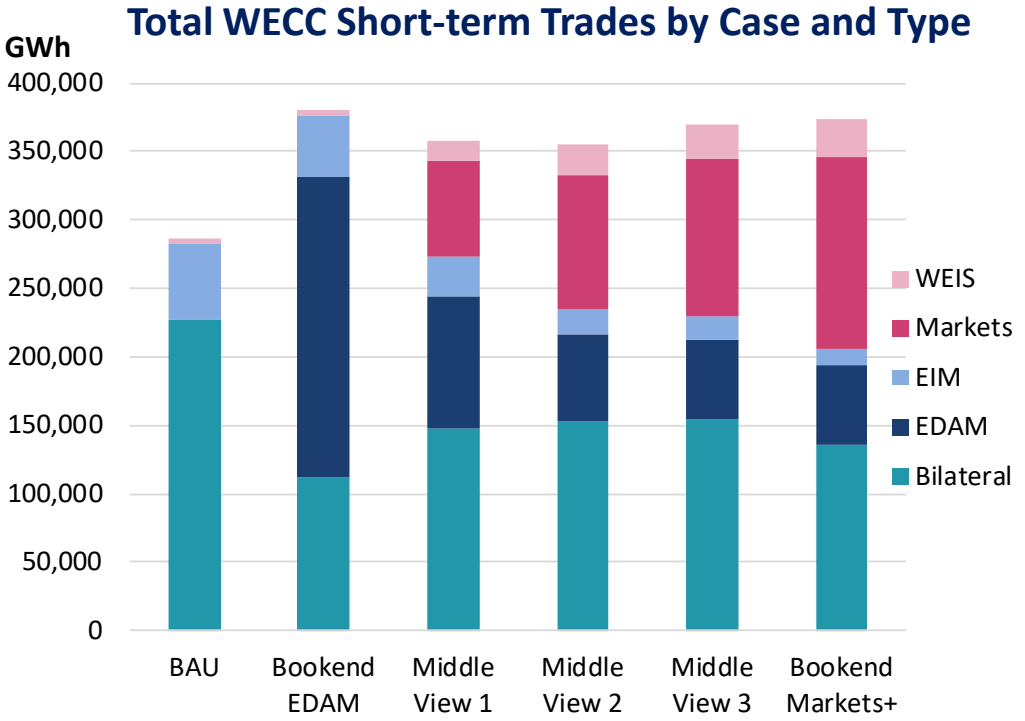
WECC-Wide Trading is Enhanced with One or Two Markets

Creating one or two optimized markets with depancaked transactions reduces trading inefficiencies relative to the status quo

- Bilateral trades between many Balancing Areas face highest "hurdles" due to low of transparency and liquidity
- Bilateral trades between organized markets generally are more efficient due to higher transparency and market-based liquidity (e.g., hourly CAISO intertie trades)

Simulations show that adding organized DA markets increases WECC-wide trading by 20-30% (60-90 TWh) relative to the "bilateral" status quo

- The case in which most WECC entities are in the same market, produces the highest increase in total trading volume
- But even two-market solutions offer more efficient trades relative to the status quo



Note: Bookend EDAM bilateral trades are mostly with non-market BAs like BCHA and AESO, and the SPP West RTO, which imports solar generation from WALC and AZPS.

Nevertheless, Market Seams Can Perpetuate Inefficiencies

While seams between RTOs will generally be more efficient than seams between non-market regions, five sources of inefficiencies across market seams are well documented:

1. **Interregional transmission planning** largely ineffective (although the WECC has better track record)
2. **Generator interconnection** delays and cost uncertainty created by affected system impact studies (and effectiveness coordination through means such as the SPP-MISO JTIQ, reducing costs by 50%)
3. **Resource adequacy** value of interties (often not considered) and barriers to capacity trades (often created by RTOs' restrictive capacity import requirements and incompatible resource accreditations)
4. **Loop flow management** inefficiencies through market-to-market coordinated flowgates (with shares of firm flow entitlements) under the eastern RTOs' Joint Operating Agreements
5. **Inefficient trading** across contract-path market seams and the need for intertie optimization (inability of bilateral trades to timely and efficiently respond to quickly-changing real-time prices)

Intertie Optimization: Efficiently Utilize Transmission Between Markets

The experience with market seams in the Eastern U.S. shows that "Intertie Optimization" will be necessary to reduce seam-related trading inefficiencies!

- NYISO, ISO-NE, and Potomac Economics have called for intertie optimization in 2010-2011 to address seam-related inefficiencies
- Only "coordinated transaction scheduling"(CTS) has been implemented between ISO-NE, NYISO, PJM, and MISO. Yet, a decade later, market monitors continue to document seams-related inefficiencies, noting that CTS has not been effective, recommending intertie optimization
- The Western energy imbalance markets and European "market coupling" experiences have shown that optimizing interties between BAAs offers substantial benefits—reducing costs, improving reliability and renewable integration
- For the seams between SPP, MISO, and PJM we estimated that, without intertie optimization, approximately 20-30% of the total transmission value ($50-60 million per 1000 MW of intertie capacity) is lost across seams due to the inability of bilateral trades to respond sufficiently quickly and efficiently to frequently-changing real-time prices

See: Intertie Optimization Report and FAQs

Thank You!

Comments and Questions?

(Additional Slides)

See also Brattle Reports on:

Intertie Optimization (incl. FAQs)
Optimal Expansion and Use of Interregional Transfer Capability
NV Energy Day-Ahead Market Benefits Studies
Extended Day-Ahead Market Benefit Study
EDAM Simulations: PacifiCorp Results

Estimated EDAM & M+ Benefits are Conservatively Low

The estimated benefits are likely understated due to several factors:

- **Overstated base-case efficiency:** our simulation of the BAU is more efficient than reality
  - The Base Case assumes that balancing authorities have optimal security-constrained unit-commitment and dispatch (SCUC and SCED) in both DA and RT, making the simulated dispatch more optimal than reality.
  - Inefficient utilization of transmission by bilateral trades is not fully modeled, understating the extent M+ and EDAM will be able to make better use of all physically and contractually available transmission.
  - Transmission outages are not modeled, which would magnify the benefit of SCED-based congestion management in EDAM and M+ compared to the BAU
- **Normalized loads and fuel prices:** the model uses weather-normalized loads and averaged monthly natural gas prices without daily volatility
  - Challenging market conditions (beyond the included heat wave and cold snap), such during as the 2022 gas price spikes, will magnify EDAM/M+ benefits. Illustrated by the WEIM experience of much higher benefits in 3Q of 2021 and 3Q-4Q of 2022
  - The Base Case does not reflect the limited liquidity of bilateral market during challenging market conditions
- **No capacity benefits quantified:** we have not quantified the extent to which EDAM and M+ may reduce investment costs associated with lower operating reserve requirements

Seams Management Assumptions

Modeling Assumption: Brattle modeled the EDAM/Markets+ seam consistent with the description from the Seams Task Force

- Exports into or imports out of Markets+ were charged a small bilateral friction charge plus the exporting entity's wheeling rate
- This is consistent with how we model the CAISO seam in the BAU Case
- Exports across the Markets+ seam into a GHG zone are charged an unspecified resource GHG cost (equivalent to the emissions charge for a generic gas-CC unit)
  - This makes Markets+ exports to CAISO and other GHG entities fairly expensive, as the GHG cost alone will be around $30/MWh

Modeled Trading Friction Charges ($/MWh)

Transaction Type	BAU Case	Markets+ Case	Pays OATT?
EIM & WEIS Transactions	$0	$0	No
Bilateral Transactions	$6	$6	Yes
ETC Transactions	$6	$6	No
RTO Intertie Transactions	$1.5	$1.5	Yes*
Block Transactions	$1.5	$1.5	Yes*
EDAM Transactions	$0	$0	No
Markets+ Transactions	$0	$0	No

Markets+ imports & exports pay either the bilateral or RTO intertie friction costs *(RTO for trades with CAISO or SPP West, who connects to PACE)*

*Note: *Block and RTO transactions won't pay an OATT rate if the transaction occurs over long-term ETC rights, just like ETC transactions broadly. The friction charge is the same regardless.*

Interregional Transmission is Poorly Utilized

For example, in the 2022 PJM State of the Market Report, the Market Monitor notes:

- Price differences across the MISO-PJM seam exceeded $10/MWh during 3,182 hours; yet during 1,570 (49%) of these hours, market flows were inconsistent with those price differences, exporting power from the higher-priced market to the lower-priced market
- On PJM-NYISO interties, price differences exceeded $10/MWh during 4,178 hours, with inconsistent market flows during 1,667 (40%) of these hours

Potomac Economics similarly observes intertie inefficiencies:

- On MISO's seams: "more than 40 percent of … transactions are ultimately unprofitable"
- Between NYISO and ISO-NE: the efficiency of real-time trades has been deteriorating, achieving "optimal" RT transactions during only 11% of all trading periods in 2022, down from 23% in 2018

This inefficiency is particularly pronounced and consequential in real-time markets, for which forecasting price differences for the next 1-2 hours is becoming increasingly more difficult

- **Day-ahead**: average (absolute) value of 2022 PJM-NYISO price difference of $12.94/MWh with price differences changing signs 3.1 times per day. With absolute PJM-MISO difference = $9/MWh, changing sign 4.1 times/day
- **Real-time**: average (absolute) PJM-NYISO price difference of $115.36/MWh with sign changing sign 47.9 times each day. With absolute PJM-MISO difference = $99.86/MWh, changing sign 62.9 times/day

Poorly-Utilized Interregional Transmission has Long Been Documented

Potomac Economics has documented inefficient utilization of interregional transmission interties since 2003

- David Patton, Coordinated Interchange Recommendations, March 13, 2003 (Presentation to New England RTO Working Group).

In 2010, Potomac Economics estimated that optimizing interties between MISO, PJM, NYISO, ISO-NE, and Canadian system operators would conservatively yield between $160-300 million in annual cost savings

- See Analysis of the Broader Regional Markets Initiatives, pp. 10-13

In 2011, NYISO and ISO-NE proposed to address these seams-related inefficiencies through intertie optimization

- See Interregional Interchange Scheduling (IRIS) Analysis and Options

Yet, little has changed and interregional interties continue to be utilized poorly

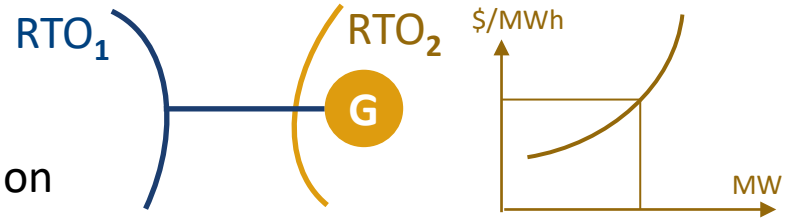
Intertie Optimization: Implementation Options

How would RTOs/ISOs determine and schedule optimal intertie transactions?

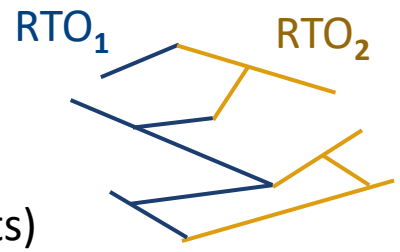
The RTOs would use their existing market optimization SCED engines to optimize intertie schedules subject to available intertie capabilities after all bilateral transactions are closed

- As the PJM IMM explains, this would: "include an optimized, but limited, joint dispatch approach that uses supply curves and treats seams between balancing authorities as constraints, similar to other constraints within an LMP market"

1. **Contract-path option**: treat the contract path across the interface like a single line with a generator (representing the neighboring region) dispatched through SCED.
   - The neighboring region would provide generation supply curve (incremental/decremental cost of importing more or less) for RT intervals
   - Simplest, will increase efficiency, but not optimally use full physical transmission



2. **Flow-based option:** represent interface physically with limiting flow gates
   - The neighboring region provides binding flow gates and marginal generators with shift factors on these flow gates (ISO-NE's 2014 IEEE "Marginal Equivalent" proposal)
   - Will use full physical capability (ISO-NE simulations achieve 99% of full optimization)



3. **Combined SCED option:** used full, multi-regional SCED (similar to Western imbalance markets)
   - Assures full optimization but likely impractical for existing market-based regions

See: Intertie Optimization, Frequently Asked Questions

Coordinated Transaction Scheduling vs. Intertie Optimization

Coordinated Transaction Scheduling (CTS)

- 75+min prescheduled 15-min transactions, based on forecasts, which often results in uneconomic trades
- Based on CTS bids by traders, who need to reserve transmission (at a cost)
- Transmission charges reduce CTS efficiency
- If transmission charges are eliminated, traders capture value of transactions (free rides)
- Experience:
  - Low transaction volume due to costs and risk of inefficient trades;
  - Has not been able to improve inefficient use of interregional transmission

Intertie Optimization

- Optimized in real time every 5 min, greatly reducing the frequency of uneconomic trades
- Optimized by RTOs using transmission that remains available after bilateral markets have closed
- Hurdle-free optimization increases market efficiency
- Value of transactions shared by RTOs (i.e., their transmission owners and, ultimately, customers)
- Experience:
  - High transaction volume with substantial benefits to participating BAAs (e.g., Western EIM)
  - Can greatly reduce inefficient use of interregional transmission (e.g., European “market coupling”)

Bottom Line: CTS is not working – not for Traders, not for RTOs, not for TOs, and not for Customers

See: Intertie Optimization, Frequently Asked Questions

FERC Has the Authority to Implement Intertie Optimization

Norman Bay and Vivien Chum (Willkie Farr & Gallagher LLP):

- FERC has long recognized the inefficiencies of market seams. *See* Order No. 888 & Order No. 2000
- FERC's authority to address seams issues is clear given its duty to ensure just and reasonable rates
- There is well established precedent for FERC to address market seams:
  - Coordinated Transaction Scheduling (ISO-NE-NYISO; NYISO-PJM; and PJM-MISO)
  - Western EIM and EIS
  - FERC precedent with respect to CTS: recognizing the value of "Tie Optimization" and leaving the door open. *See NYISO*, 139 FERC ¶ 61,048 (2012) (recognizing the possibility of replacing CTS with a "different methodology for scheduling external transactions (i.e., Tie Optimization or a superior alternative), if it is determined that such changes could result in greater cost savings")
- If the RTOs/ISOs propose intertie optimization, FERC has the clear authority to accept the filing under section 205. FERC would also be able to require intertie optimization under FPA section 206

Estimated Value of Intertie Optimization: SPP, MISO and PJM

Volatility of price differences between SPP, MISO, and PJM shows that intertie optimization is needed to capture 20-30% of the total real-time transmission value

- Our analysis 2020-2022 price differences point to a high "book-end" value if interregional transfer capacity could be used more optimally for RT energy market transactions
  - **Bilateral trades** that respond to observed RT price differences with a 1-2 hour delay would typically **capture only 70-80%** of the total energy value of interties, including during reliability events
  - The value that cannot be captured by through bilateral trades consequently is roughly **20-30% of the total real-time value** (assuming a 1-2 hour delay of trades in response to observed prices)

This represents an average value of approx. $50-60 million/year for every 1,000 MW of intertie capacity

  - It can only be captured by system operators through automated operational means, such as intertie optimization or an interregional energy imbalance market (similar to the Western EIM or EIS)

For merchant transmission lines, intertie optimization revenues would need to accrue to either the transmission owner or its subscribers

  - See CAISO Subscriber PTO proposal

Estimated value of intertie optimization (detailed results)

Approach (based on LBNL framework): Value of 1000 MW of trade based on differences in hourly real-time energy prices for nodes in western SPP, central MISO, and western PJM

		SPP > MISO	MISO > SPP	MISO > PJM	PJM > MISO	SPP > PJM	PJM > SPP
Value with No Trading Delay ($ million)	[1]						
2020		$91	$27	$26	$23	$93	$26
2021		$189	$136	$69	$44	$222	$143
2022		$338	$53	$144	$58	$410	$39
Value with 1 Hour Delay ($ million)	[3]						
2020		$76	$10	$13	$11	$79	$10
2021		$165	$108	$46	$22	$198	$117
2022		$307	$23	$104	$20	$384	$14
Value with 2 Hour Delay ($ million)	[4]						
2020		$71	$7	$11	$9	$75	$7
2021		$150	$95	$39	$17	$185	$107
2022		$290	$8	$91	$7	$372	$3
Value of Intertie Optimization ($ million)	[1] - [3]						
1 Hour Delay: 2020		$15	$17	$13	$12	$14	$16
2021		$24	$28	$24	$21	$24	$26
2022		$31	$30	$40	$39	$26	$25
	[1] - [4]						
2 Hour Delay: 2020		$20	$20	$16	$13	$18	$19
2021		$39	$41	$30	$26	$37	$37
2022		$48	$46	$53	$51	$38	$35

Bidirectional Intertie		SPP-MISO	MISO-PJM	SPP-PJM
Annual Average Value with No Trading Delay ($ million)	[1]	$278	$122	$311
Annual Average Value with 1 Hour Delay ($ million)	[3]	$230	$72	$267
% Value Lost Due to Delay	1 - ([3]/[1])	17%	41%	14%
Annual Average Value with 2 Hour Delay ($ million)	[4]	$206	$58	$250
% Value Lost Due to Delay	1 - ([4]/[1])	26%	52%	20%
Annual Average Value of Intertie Optimization ($ million)				
One hour	[1] - [3]	$48	$50	$43
Two hour	[1] - [4]	$71	$63	$61

Approx. $50-60 million/yr per 1000 MW

About the Speaker

Johannes P. Pfeifenberger

PRINCIPAL
BOSTON

Hannes.pfeifenberger@brattle.com

+1.617.234.5624

Johannes (Hannes) Pfeifenberger, a Principal at The Brattle Group, is an economist with a background in electrical engineering and over twenty-five years of experience in wholesale power market design, renewable energy, electricity storage, and transmission. He also is a Visiting Scholar at MIT's Center for Energy and Environmental Policy Research (CEEPR), a Senior Fellow at Boston University's Institute of Sustainable Energy (BU-ISE), a IEEE Senior Member, and currently serves as an advisor to research initiatives by the U.S. Department of Energy, the National Labs, and the Energy Systems Integration Group (ESIG).

Hannes specializes in wholesale power markets and transmission. He has analyzed transmission needs, transmission benefits and costs, transmission cost allocations, and renewable generation interconnection challenges for independent system operators, transmission companies, generation developers, public power companies, industry groups, and regulatory agencies across North America. He has worked on transmission matters in SPP, MISO, PJM, New York, New England, ERCOT, CAISO, WECC, and Canada and has analyzed offshore-wind transmission challenges in New York, New England, and New Jersey.

He received an M.A. in Economics and Finance from Brandeis University's International Business School and an M.S. and B.S. ("Diplom Ingenieur") in Power Engineering and Energy Economics from the University of Technology in Vienna, Austria.

Brattle Group Practices and Industries

ENERGY & UTILITIES

- Competition & Market Manipulation
- Distributed Energy Resources
- Electric Transmission
- Electricity Market Modeling & Resource Planning
- Electrification & Growth Opportunities
- Energy Litigation
- Energy Storage
- Environmental Policy, Planning and Compliance
- Finance and Ratemaking
- Gas/Electric Coordination
- Market Design
- Natural Gas & Petroleum
- Nuclear
- Renewable & Alternative Energy

LITIGATION

- Accounting
- Analysis of Market Manipulation
- Antitrust/Competition
- Bankruptcy & Restructuring
- Big Data & Document Analytics
- Commercial Damages
- Environmental Litigation & Regulation
- Intellectual Property
- International Arbitration
- International Trade
- Labor & Employment
- Mergers & Acquisitions Litigation
- Product Liability
- Securities & Finance
- Tax Controversy & Transfer Pricing
- Valuation
- White Collar Investigations & Litigation

INDUSTRIES

- Electric Power
- Financial Institutions
- Infrastructure
- Natural Gas & Petroleum
- Pharmaceuticals & Medical Devices
- Telecommunications, Internet, and Media
- Transportation
- Water

Our Offices


BOSTON


BRUSSELS


CHICAGO


LONDON


MADRID


NEW YORK


ROME


SAN FRANCISCO


SYDNEY


TORONTO


WASHINGTON, DC