

Intertie Optimization: Lessons from the East

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Seams Inefficiencies: What Exactly are we Talking About?

Several seams-related inefficiencies exist between markets:

1. **Interregional transmission planning** is generally ineffective (mostly pursued by merchant developers)
2. **Generator interconnection** delays and cost uncertainty created by affected system impact studies
 - Effective coordination can reduce costs (e.g., SPP-MISO JTIQ)
3. **Loop flow management** through market-to-market coordinated flowgates (with shares of firm flow entitlements) under JOAs is necessary (but still plagued by design inefficiencies)
4. **Inefficient trading** across market seams
 - **Intertie bidding** to improve energy trading (particularly in day-ahead)
 - **Intertie optimization** for real-time optimization (after bilateral trading is closed)
5. **Resource adequacy** value of regional connections are often not considered in RA evaluations and barriers to capacity trades (often created by markets' restrictive capacity import requirements and incompatible resource accreditations) can increase costs

These Inefficiencies Have Always Existed in the WECC...

... and there is a long tradition of regional cooperation to address them

1. Interregional transmission planning

- WestTEC
- Public/private/merchant partnerships
- Jointly owned projects

2. Generator interconnection

3. Loop flow management

4. Inefficient trading

- CAISO Intertie Bidding
- WEIM and WEIS
- Liquid trading hubs (e.g., Mid-C, Malin, PV, 4C)

5. Resource adequacy

- WRAP
- EDAM RA Program

The emerging day-ahead markets will not necessarily increase inefficiencies, some features may improve efficiency (e.g., Markets+ mandated economic bidding on interties)

My Focus Today: Economic Trading at the Seams



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Lessons from the East

Poor Intertie Utilization has a Long History & Continues Today



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](#)

NYISO/ISO-NE Recommended Intertie Optimization but CTS was Implemented Instead

NYISO and ISO-NE offered designs for two possible solutions:

- Intertie Optimization: similar to the least-cost economic dispatch system used internally for each ISO's energy market, it relies on the bid-based supply offers from generators and demand resources to determine real-time LMPs and transmission flows within and between the two ISOs' networks.
- Coordinated Transaction Scheduling (CTS): facilitates bilateral trading in real time through a simplified bid format (called an interface bid) and coordinated acceptance of interface bids by the ISOs (using an improved clearing rule).

The ISOs recommended the Intertie Optimization because:

- Intertie optimization is the more efficient solution
- The CTS system was not expected to produce as complete a price convergence between regions

Only CTS was implemented between NYISO and ISO-NE (and later PJM and MISO):

- Concerns were raised that intertie optimization may unnecessarily displace bilateral trading
- It was hoped that CTS might be almost as efficient as intertie optimization

CTS has not been Successful in Reducing Seams Inefficiencies

PJM's IMM found that >50% seams trades were uneconomic with MISO and NYISO

Even in hours with high price differences a large share were uneconomic

Distribution of Hourly Flows that are Consistent and Inconsistent with Price Differences between PJM and MISO/NYISO (2022)

Price Difference Range (Greater Than or Equal To)	Percent of Inconsistent		Percent of Consistent		Price Difference Range (Greater Than or Equal To)	Percent of Inconsistent		Percent of Consistent	
	Hours	Hours	Hours	Hours		Hours	Hours	Hours	Hours
\$0.00	4,176	100.0%	4,584	100.0%	\$0.00	3,463	100.0%	5,297	100.0%
\$1.00	3,773	90.3%	4,190	91.4%	\$1.00	3,193	92.2%	5,021	94.8%
\$5.00	2,517	60.3%	2,737	59.7%	\$5.00	2,327	67.2%	3,834	72.4%
\$10.00	1,570	37.6%	1,612	35.2%	\$10.00	1,667	48.1%	2,511	47.4%
\$15.00	989	23.7%	1,056	23.0%	\$15.00	1,206	34.8%	1,664	31.4%
\$20.00	673	16.1%	700	15.3%	\$20.00	912	26.3%	1,173	22.1%
\$25.00	490	11.7%	531	11.6%	\$25.00	709	20.5%	881	16.6%
\$50.00	150	3.6%	243	5.3%	\$50.00	360	10.4%	360	6.8%
\$75.00	65	1.6%	137	3.0%	\$75.00	220	6.4%	209	3.9%
\$100.00	38	0.9%	94	2.1%	\$100.00	143	4.1%	133	2.5%
\$200.00	26	0.6%	34	0.7%	\$200.00	49	1.4%	54	1.0%
\$300.00	19	0.5%	15	0.3%	\$300.00	22	0.6%	28	0.5%
\$400.00	17	0.4%	8	0.2%	\$400.00	14	0.4%	24	0.5%
\$500.00	15	0.4%	6	0.1%	\$500.00	9	0.3%	20	0.4%

Source: [2022 State of the Market Report for PJM \(monitoringanalytics.com\)](#)

MISO IMM Analysis of CTS with 5-Minute Clearing vs. Current CTS (2021)

	Percent of Intervals Adjusted	Production Cost Savings	Profits	Percent Unprofitable
PJM				
Current CTS	9.7%	\$7,203,734	\$199,456	39.4%
5-Minute CTS	77.5%	\$23,207,329	\$11,765,360	13.8%
SPP				
5-Minute CTS*	89.6%	\$44,089,866	\$25,984,814	22.1%

* Results omit Feb. 13-19 when SPP experienced very high prices from the Arctic Event.

Source: MISO [2021 State of the Market Report](#)

MISO's IMM estimated that 40% of CTS transactions with PJM were uneconomic

5-min CTS cleared based on prices in the neighboring RTO reduces costs by ~\$70 million/yr on the PJM and SPP seams

MISO announced earlier this month that they are retiring CTS

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”)

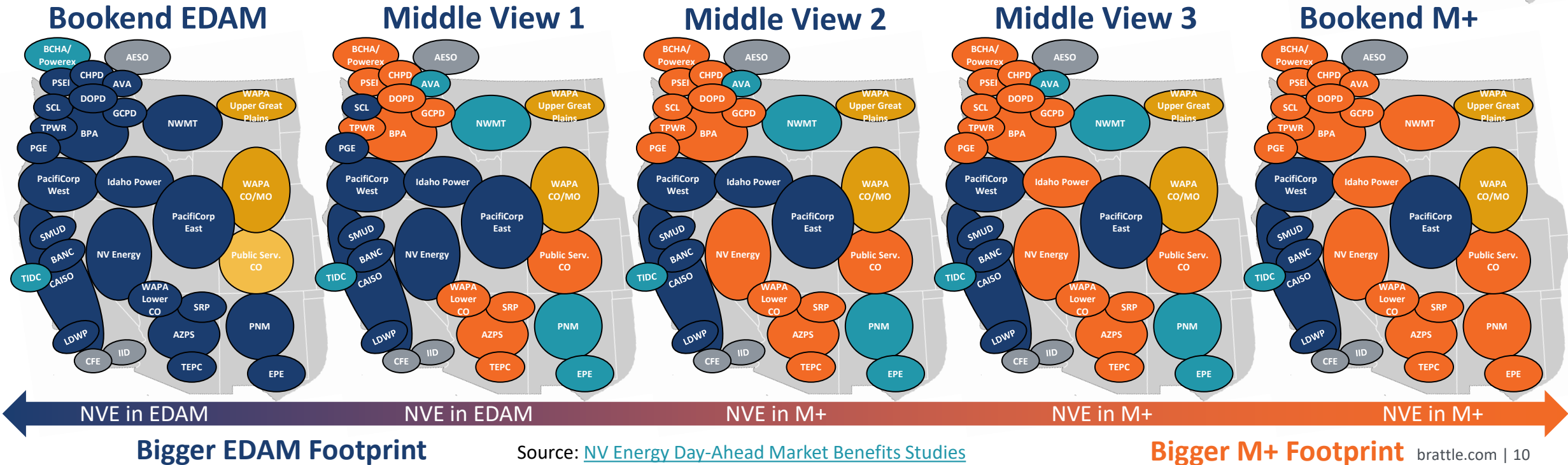
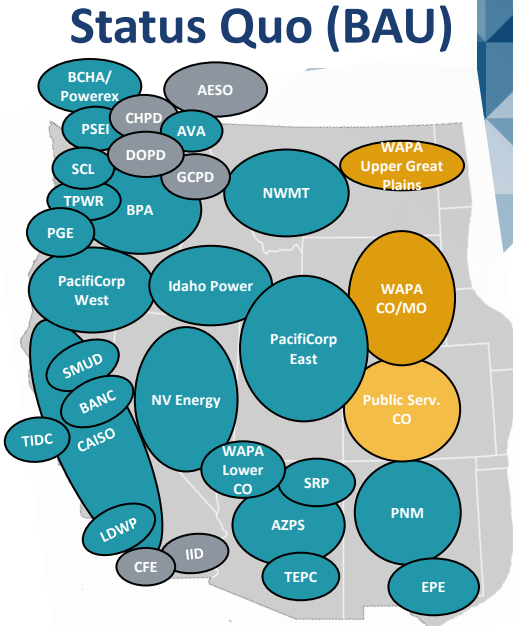
Potential Value of Intertie Optimization in the WECC

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



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 produces modestly lower benefits
- The difference across the different footprints illustrates the potential benefit of intertie optimization

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

Potential benefit of intertie optimization could be as large as ~\$150 million/year in the WECC

All market participation scenarios show benefits relative to Status Quo (BAU)



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](#)

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

Speaker Bio



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John has broad experience helping clients address a range of issues related to wholesale power markets. He is an expert in electric market modeling, analyzing regional market participation, transmission benefit-cost analysis, transmission rate design, market design, detection of market manipulation and damages analyses, and strategic planning.

John has worked with electric utilities, cooperatives, public power authorities, transmission developers, generation owners, power traders, and ISO/RTO staff. He has assisted clients in developing whole market rules, ancillary service product, designing market power mitigation regimes and auction clearing mechanics, leading strategic planning initiatives, and modeling the power system to assess the benefits of new transmission, the benefits of participating in wholesale power markets, and the value generation assets.

John has provided expert testimony to FERC, provincial regulators in Canada, and in U.S. Federal Court related to transmission rate cases, alternative transmission rate designs, cost allocation, and contracts for wholesale power.

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