

Modeling Seams:

Capturing the Inefficiency of Interregional Trading

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PRESENTED AT



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Market-to-Market Seams Can Result in Inefficiencies



[NREL's 2024 Interregional Transmission Barriers Report](#) documents and analyzes existing seams-related inefficiencies between US market areas:

- **Uneconomic Flows**: Frequently power flows from higher-price areas to lower-price areas
- **High Price Differentials**: Significant spreads in power prices between regions when transmission is not constrained indicates opportunities to reduce customer costs
- **Underutilized Transmission Capacity**: in combination with persistent price differences, means that transmission assets are not being used efficiently to bring lower-priced power to higher-priced regions.
 - Could be driven by inefficient matching of holders of transmission rights and buyers/sellers of energy
- **Lack of Transparency on Inefficiencies**: lack of transparency in interchange transactions is an obstacle to identifying inefficiencies—and opaqueness is more likely to occur in areas without regional organized markets (e.g., lack of market monitoring)
- **Real-time (RT) Scheduling Risk**: RT market seam trades are often scheduled in advance of the real-time dispatch to align with bilateral transmission scheduling requirements. The resulting price uncertainty creates risk for exporters & importers that can reduce seam trading efficiency

Seams-related inefficiencies also relate to **loop flows** imposed by one region's market-dispatch on its neighboring regions, causing both reliability concerns and congestion management challenges

Production Cost Modeling Tends to Miss These Inefficiencies



Modeling typically understates the inefficiencies of seams for various reasons:

- Weather-normalized load, renewable profiles, and thermal resource outages reduce price variability and do not capture scarcity events that can increase illiquidity in seams trading.
- Simulation of only a single decision cycle, typically as a proxy for day-ahead transactions, misses inter-day variability that create inefficient trading.
- Hourly trading missing intra-hour variability that creates inefficiencies in seams trading.
- Hurdle rates used to represent seams frictions tend to overstate the liquidity of trading and the efficiency of transmission usage.
- Not representing existing transmission contracts in the model overstates the availability of transmission for seams transactions, and the economic efficiency of seams transactions (as contracts may shield market participants from prices on either side of a seam).

Production Cost Modeling Tends to Miss These Inefficiencies



By understating the inefficiencies of interregional seams, production cost modeling can distort results related to key study questions, such as:

- The energy arbitrage value and production costs savings related to new transmission assets tends to be understated because the efficient use of existing transmission infrastructure is usually overstated.
- The value of regional centralized markets can be understated because bilateral seams trading in the absence of a centrally-dispatched market is typically modeled as overly efficient.
- The value of generation assets can be understated, due to unrealistically high volumes of interregional trading that reduces congestion in one market and due to the lack of scarcity pricing in some regions.
- The impact of changes to market rules can be misstated if price formation or unit commitment/dispatch in the model do not accurately reflect price formation commitment/dispatch in the market.

Modeling Enhancements to Capture Seams Inefficiencies

The Brattle modeling team has developed several improvements to more accurately capture seam inefficiencies (and other aspects of trading/market operation):

- **Weather-reflective modeling** that incorporates the full range of historical system variability.
- **Multiple decision cycles** to capture uncertainty and variability across the day-ahead, intra-day, hour-ahead, and the real-time.
- **Sub-hourly real-time modeling** to illustrate the value of 15 or 5-minute scheduling and dispatch in organized markets, which cannot be achieved with bilateral trading across seams without some form of seams optimization and coordination.
- **More detailed representation of bilateral trading**, including:
 - Block trading
 - Major trading hubs
 - Representation of various bilateral trade types
 - Reflecting existing transmission contracts and related contractual obligations

Weather-Reflective Modeling

Brattle's Weather and Resource Adequacy Sampling (WRAS) tool creates a weatherreflective proxy year with appropriately probability weighted multi-day periods reflecting the range of load, renewable, and generation outage conditions that are expected to occur over the course of 20+ weather years. **WRAS greatly enhances the representation of scarcity conditions and price variability that can drive interregional trading.**

- Weather-reflective modeling more accurately captures the value of new transmission assets, battery storage technologies, and conventional generation assets as it better predicts market congestion and prices.

INPUTS

20+ weather years of system-wide and zonal data:

- Load forecasts for weather years
- Wind, solar, and hydro profiles (including multi-day renewable droughts and variable hydro conditions) for weather years
- Planned and forced generation outages (including high hot/cold weather outages)



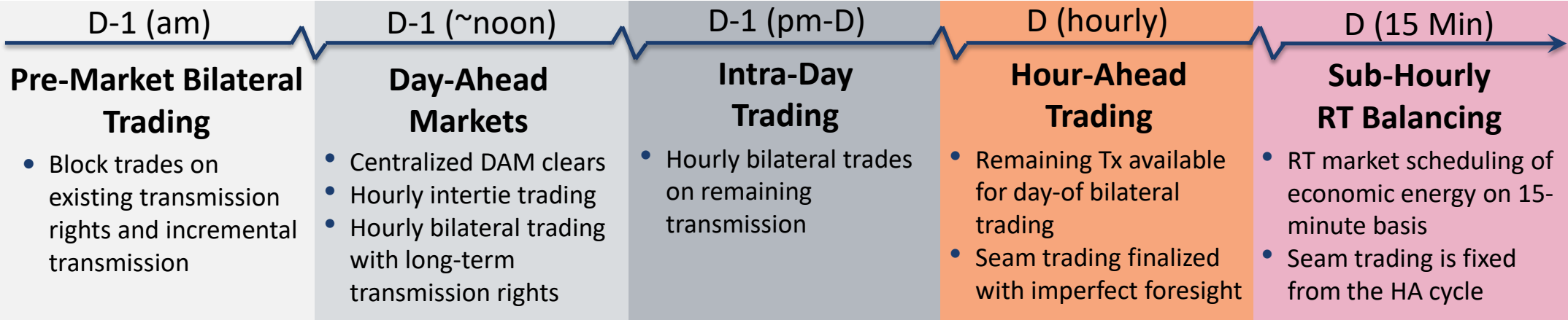
WRAS

OUTPUTS

- Proxy year composed of multi-day proxy periods (or proxy weeks)...
- ... that reflects the renewable, load, and generation outage conditions that are expected to occur over many weather years
- Load and renewable/hydro generation profiles for each of the multi-day proxy periods
- Weights for each proxy period that reflect the expected frequency over entire weather sample

Multiple Decision Cycles with Sub-Hourly Real-Time Granularity

Multiple decision cycles and sub-hourly RT optimization allows us to more accurately simulation operational decision-making in the face uncertainty and system variability



Typical PCMs simulate one decision-point that combines all DA bilateral and market trading.

Brattle’s approach separates operation time frames into sequential independent “cycles” in the model that allows us to capture differences between bilateral trading and market trades across different operational time frames.

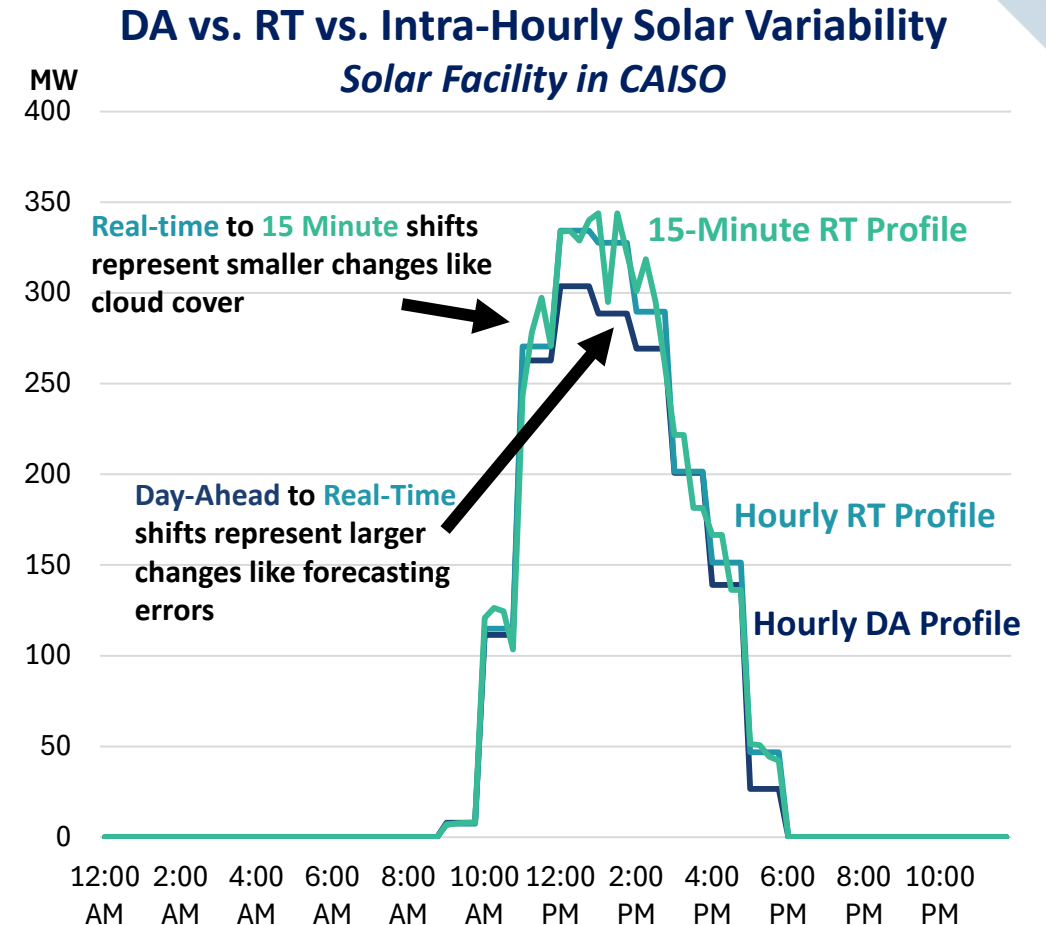
Hour-ahead cycle captures imperfect foresight when making trades across market seams, which must be tagged prior to RT.

RT cycle allows us to capture intra-hour variability and differentiate seam trading (hour ahead) vs market clearing (sub-hourly)

Multiple Decision Cycles with Sub-Hourly Granularity: RT Variability

On top of load and renewable uncertainty modeled between the day-ahead and real-time, we have developed intra-hour renewables variability to add to the 15-minute cycle

- This variability is applied such that for all renewables:
 - There is a **day-ahead** profile developed from client or NREL data
 - There is a **real-time** profile where we apply observed historical day-ahead forecast error
 - We add a **real-time 15-minute** profile comprising intra-hour variability added to the real-time profile
- For both wind and solar we have **developed models from which to sample 15-minute variability** to apply variability to the existing hourly renewable profiles

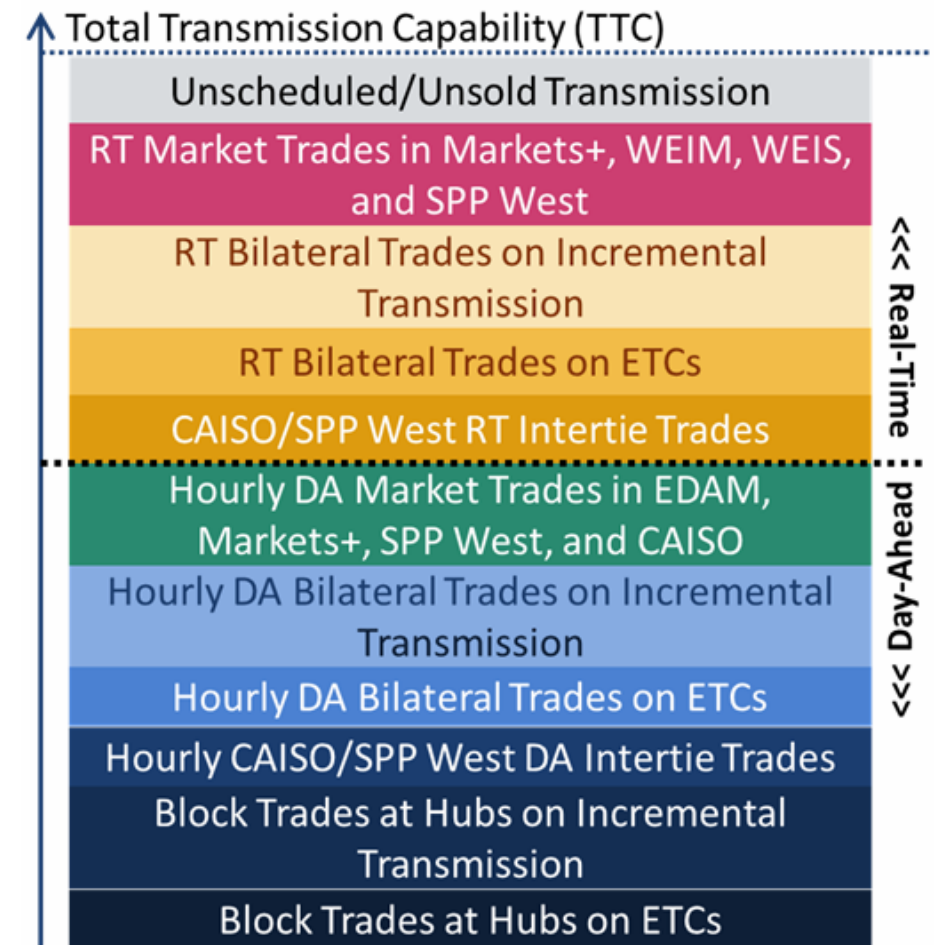


Diversity of Trades and Transmission Costs/Availability

PCMs typically account for physical transmission limits but fail to account for contract path limits (e.g., who has rights to use specific transmission paths) and the differences in costs/availability of certain transmission reservations.

- We apply both the physical transmission topology and contract path constraints to capture both layers of transmission limits.
- Existing transmission contracts (ETCs) allow rightsholders to execute trades without paying for short-term transmission and may limit who else can use the transmission capacity.
- Trades can be structured as blocks at certain locations.
- Trading opportunities that are executed in DA may be unprofitable in RT or vice versa (e.g., seam transactions executed HA may lose money in RT).
- In non-RTO areas, unscheduled transfer capability is released for market transactions (e.g., EDAM, WEIM, SEEM).

Example: Trades Modeled in the WECC





Thank You!

Comments and Questions?

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](#)

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.