

Integrating Physical & Financial

Optimal Real-time Operations Of Storage and Hybrids

Physical

- Asset Operations
- Weather
- Load
- Renewables
- Capacity

Financial

- DART
- Must Offer Obligations
- Structured Transactions
- Hedge Evaluation
- Asset Valuation

About Ascend Analytics

- Founded in 2002 with ~100 employees in Boulder, Oakland, and Bozeman
- Six integrated service lines for asset operations, portfolio analytics, and planning
- Custom analytical solutions and consulting

The Ascend Product Suite

DAILY OPS
5 minutes to 5 days

VALUATION/SITING
1 month to 30 years

HEDGING & PLANNING
1 month up to 30+ years

MARKET FORECAST
Next month to 30 years

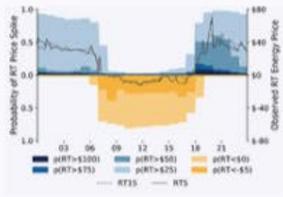
MERCHANT FINANCE
5 to 10 years

TRANSACTIONS
Development Cycle

 **SmartBidder™**

Bid Optimization & Scheduling Services

Forecasts Future Grid States



 **BatterySIMM™**

Energy Storage & Renewables Valuation

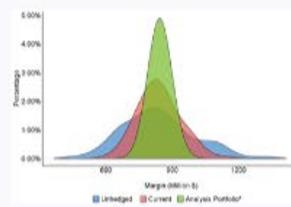
Capture Nodal Volatility



 **PowerSIMM™**

Portfolio Risk Management & Resource Planning

Evaluate Risk & Return

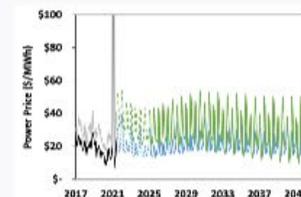


 **AscendMI™**

Market Intelligence

Price & Market Forecasts for the Energy Transition

Market Forwards & Forecasts

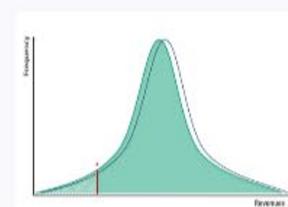


 **Ensurance™**

Merchant Storage Financing

Finance Merchant Storage

Toll Secures Fixed Income



 **AEX**

Ascend Energy Exchange

Clean Asset Marketplace

Project Sales



The Four Causes of Volatility

- 1) High percentage of renewables
- 2) Weather-related Events
- 3) Failures in the distribution system
- 4) Demand Fluctuations

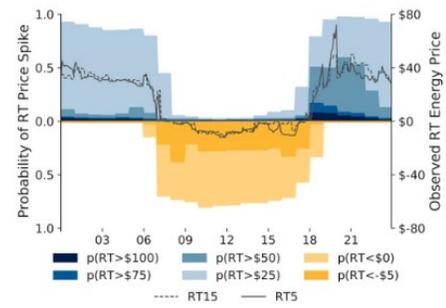




SmartBidder™

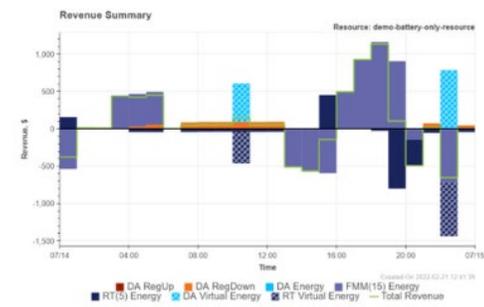
SmartBidder is a platform that automates ISO bids and offers scheduling services to optimize storage, renewables, Hybrids and load. The platform enables highly customized bid strategies based on market fundamentals and risk Preferences using machine learning models for the day-ahead, real-time and ancillary markets.

System & Price Forecasting



AI models probabilistically forecast price conditions for each asset, including likelihood of extreme events, price spreads, and likelihoods

Maximize Revenue



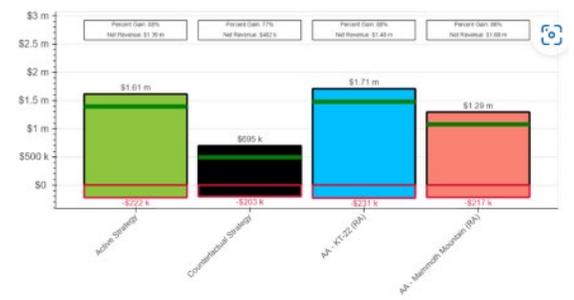
Evolving physical and virtual bidding strategies are paired with hedging to provide risk-adjusted, optimal returns while following all warranty and physical constraints

Market Fundamentals



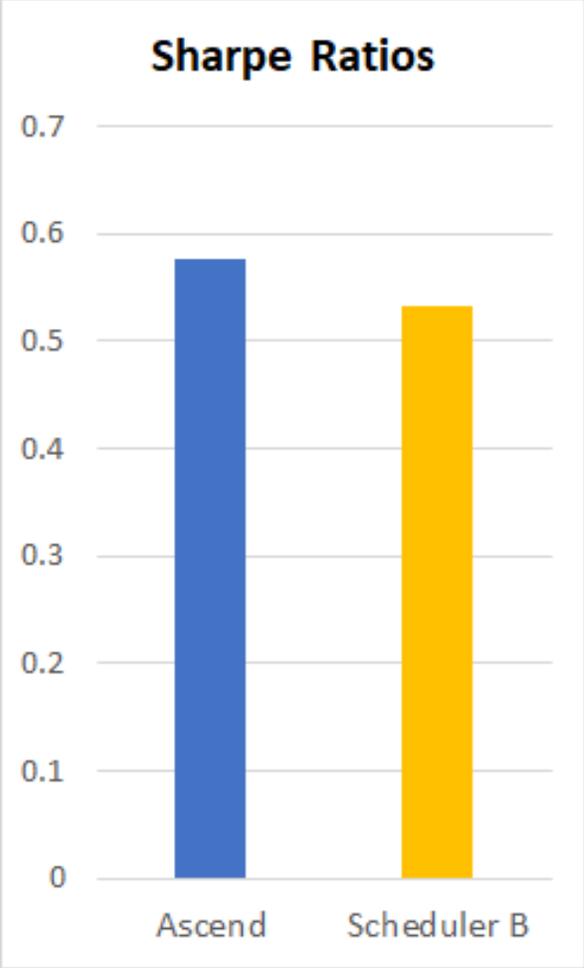
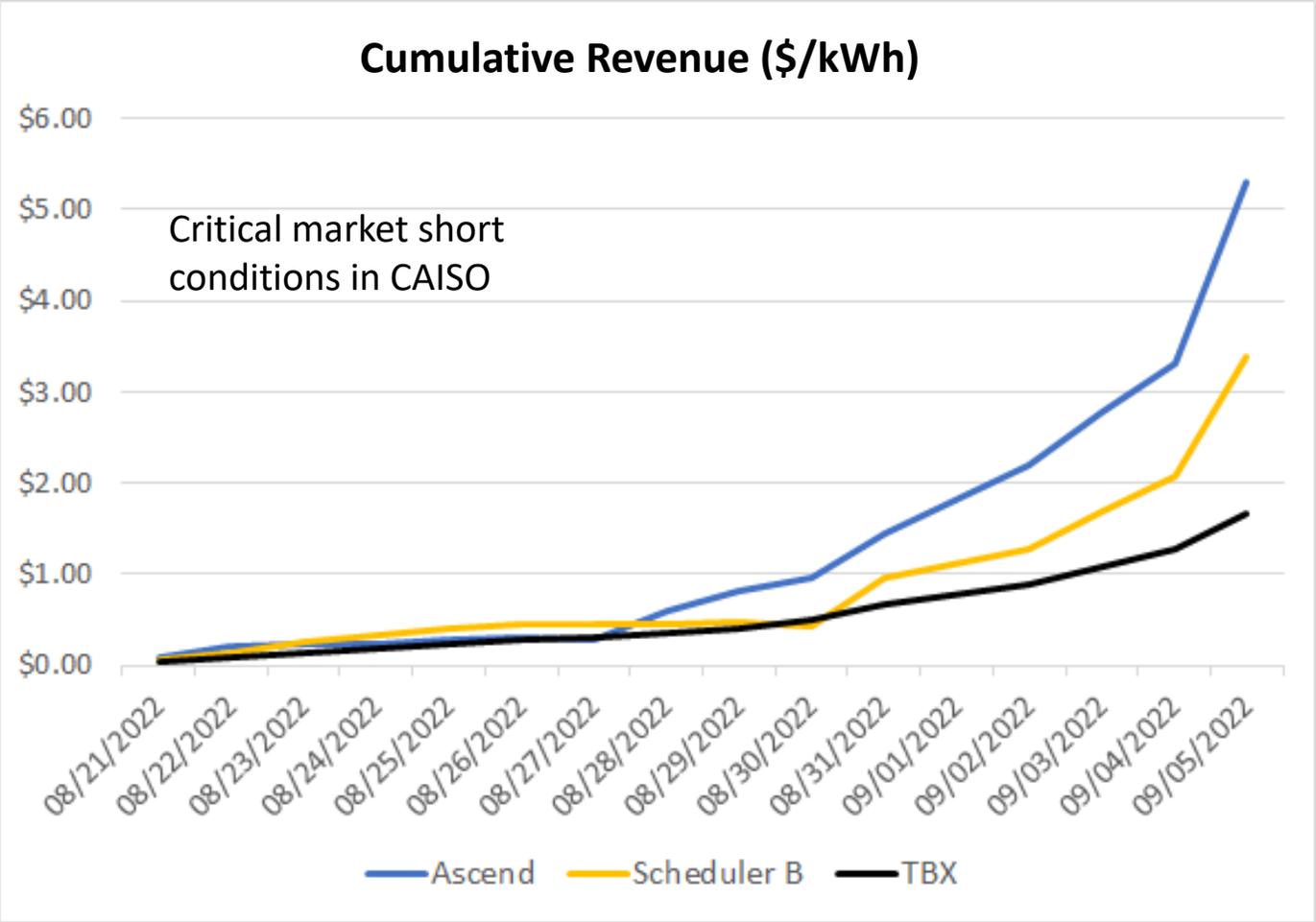
AI models utilize market fundamentals, such as transmission flows, outages, and supply conditions

Risk Based Bidding



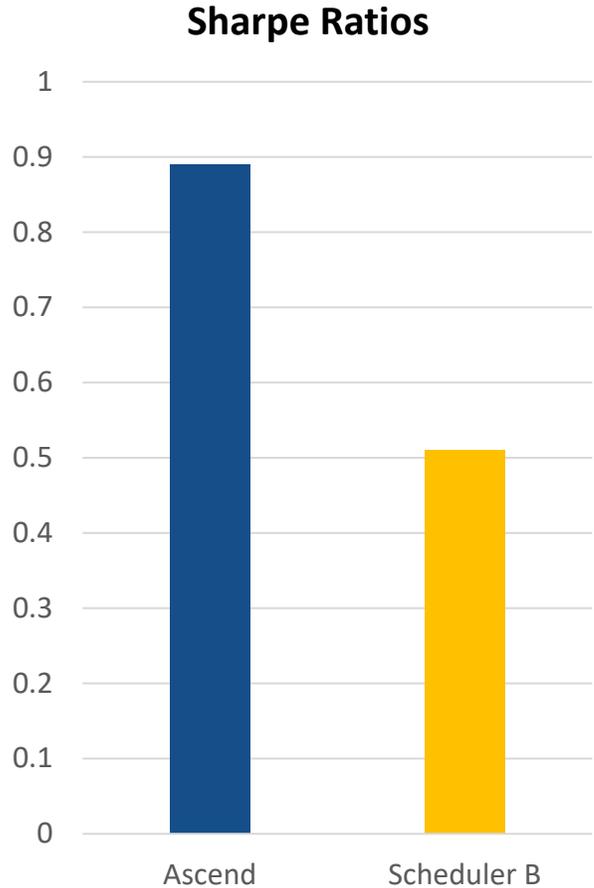
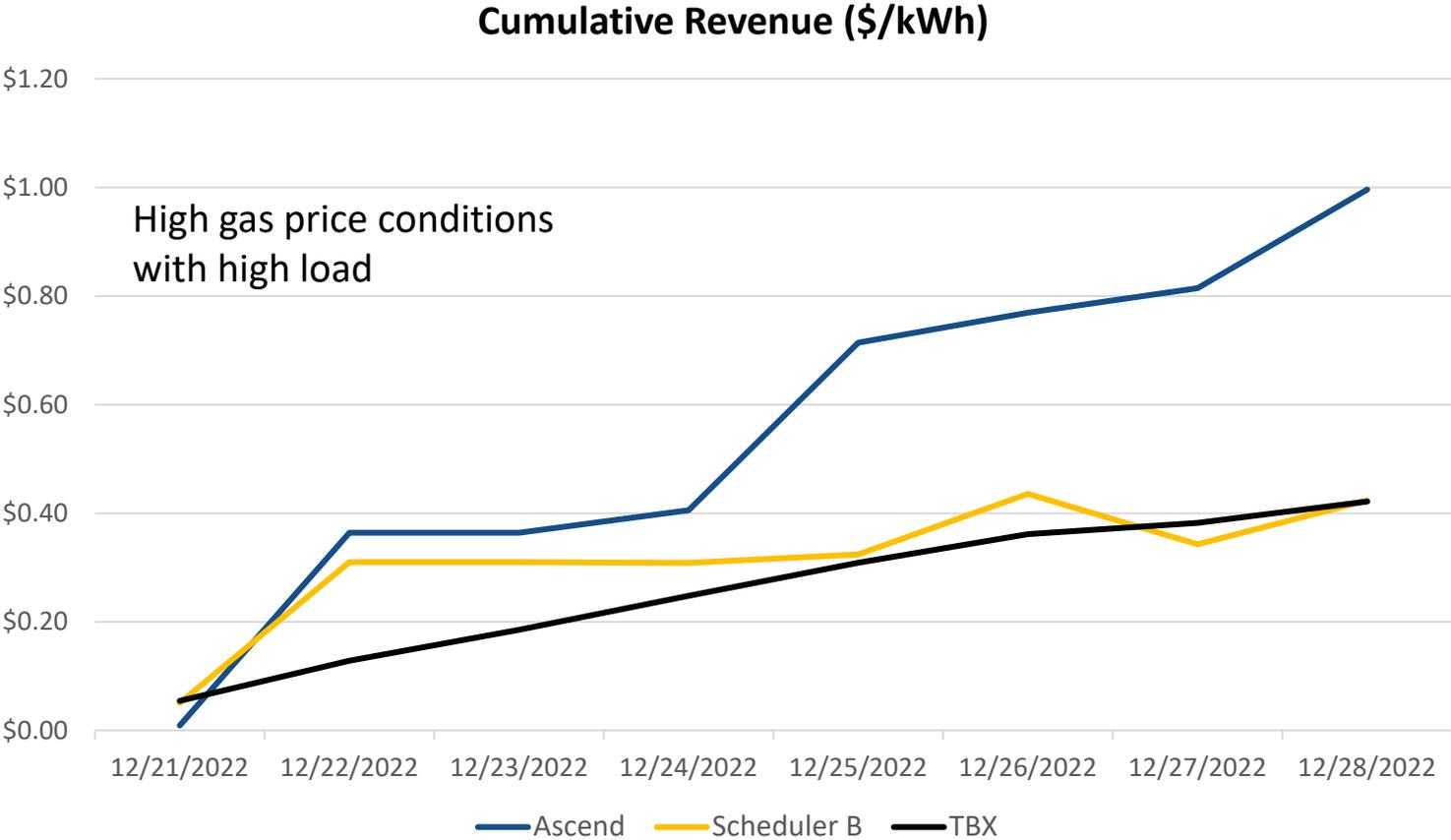
Bidding strategies account for client's risk tolerance when maximizing risk-adjusted returns

Performance Compared to Competitors in Scarce Conditions



Ascend has non-normalized 57% greater return.
 Normalized for node and outages **68%** greater.

Comparative Performance Results in Scarce Conditions



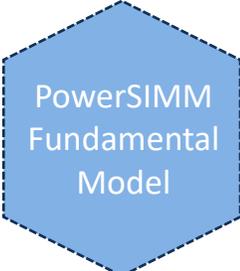
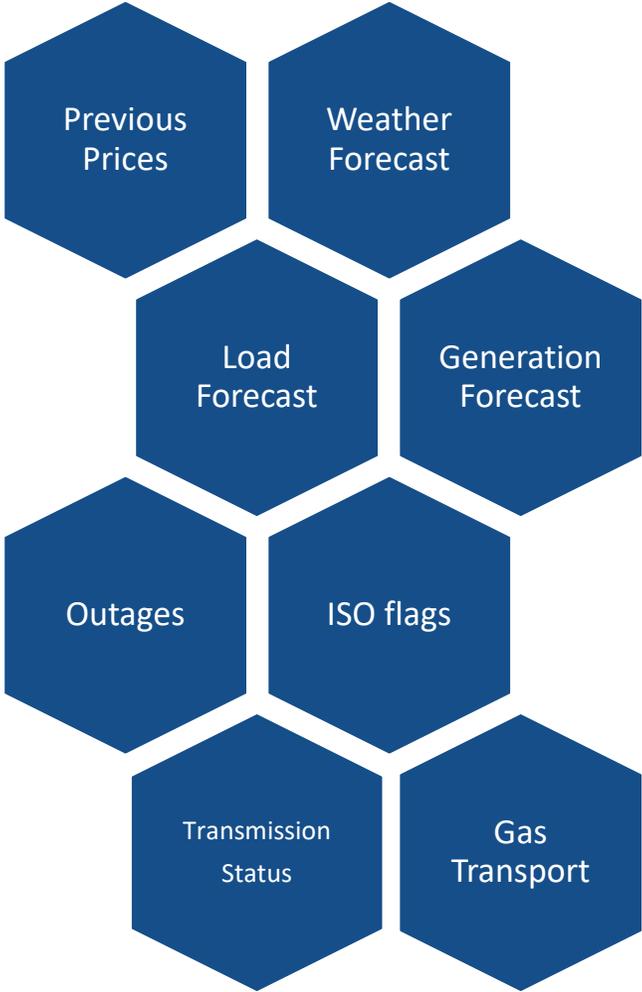
Ascend has non-normalized 135% greater return.
Normalized for node **147%** greater.



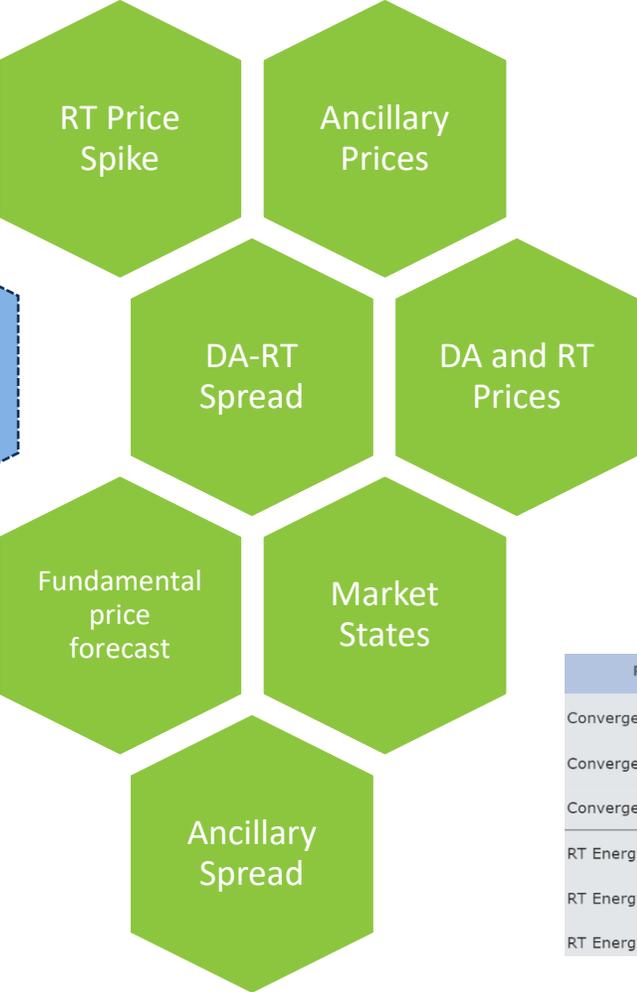
Modeling is a Mosaic

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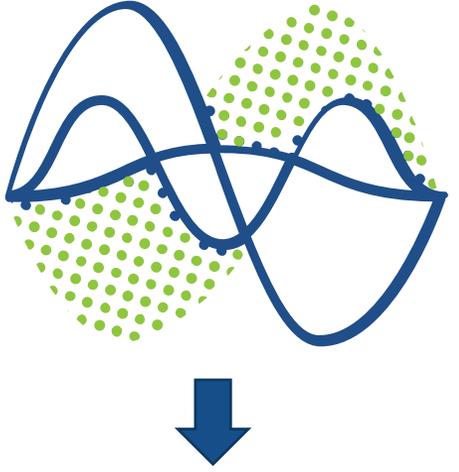
Inputs



Forecasts



Bid Optimization within Risk Constraints

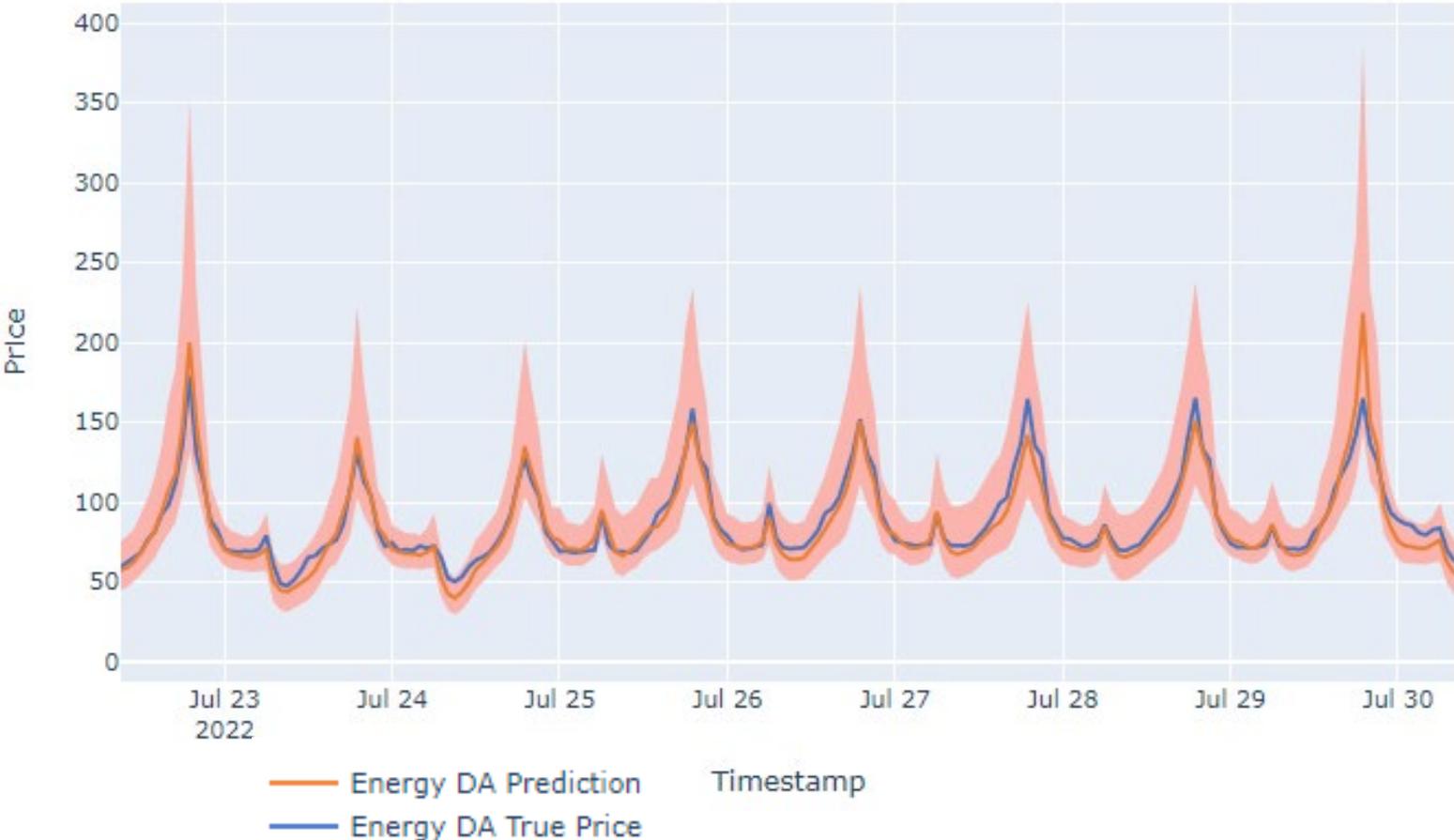


Bid Output

Product	Parameter	HE01	HE02	HE03	HE04	HE05
Convergent RT Energy	Segment Start, MW	-10.00	-10.00	-10.00	-10.00	-10.00
Convergent RT Energy	Segment End, MW	0.00	0.00	0.00	0.00	0.00
Convergent RT Energy	Segment Price, \$/MWh					
RT Energy	Segment Start, MW	0.00	0.00	0.00	0.00	0.00
RT Energy	Segment End, MW	2.09	2.62	3.04	3.29	3.29
RT Energy	Segment Price, \$/MWh	109.02	107.30	107.14	106.98	106.83

Day-Ahead Absolute Price Forecasting (A Mosaic Piece)

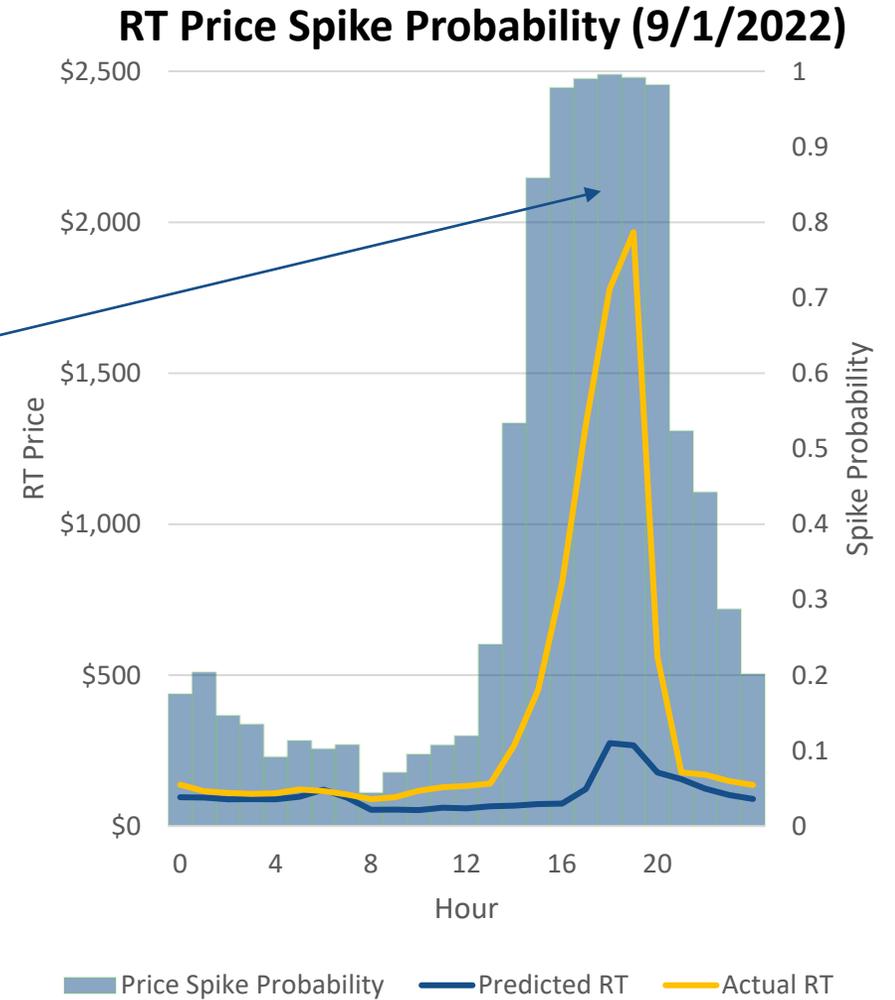
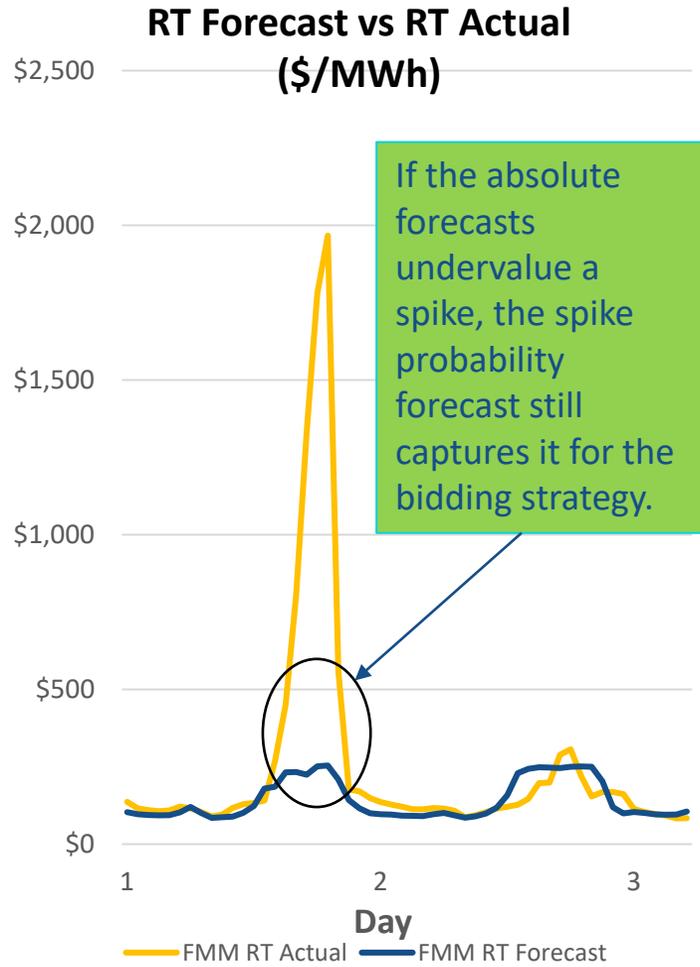
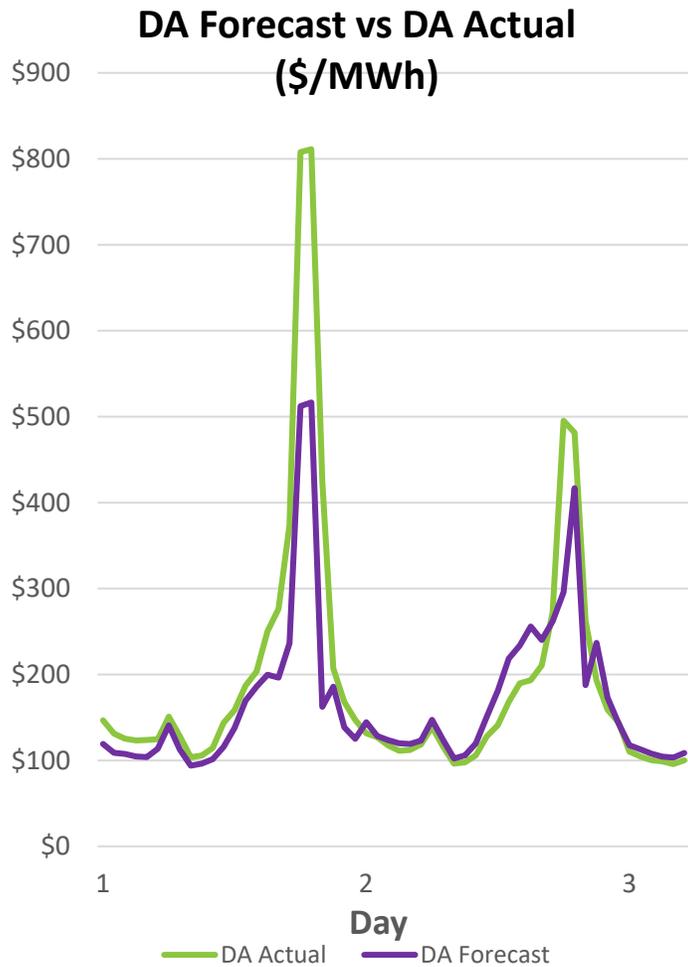
Energy DA Price Prediction



State-of-the-art, data-driven deep learning approach with encoder decoder and attention mechanisms. Consistently captures spikes and supports better bidding decisions

The DA Absolute forecast predicts complex price dynamics and is augmented by additional models that offer other perspectives.

Multiple Models in Volatile Periods (9/1/2022-9/2/2022)



Multiple models allow for better decisions

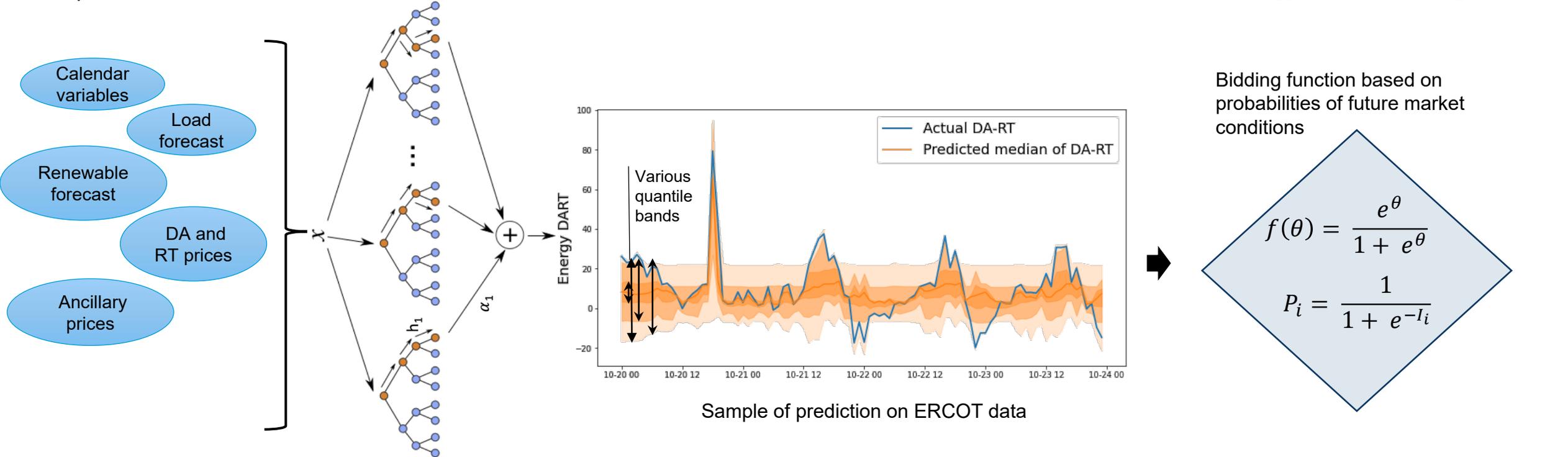
Probabilistic forecasting models allow for better decision-making

Input features

Ensembled of trained decision trees

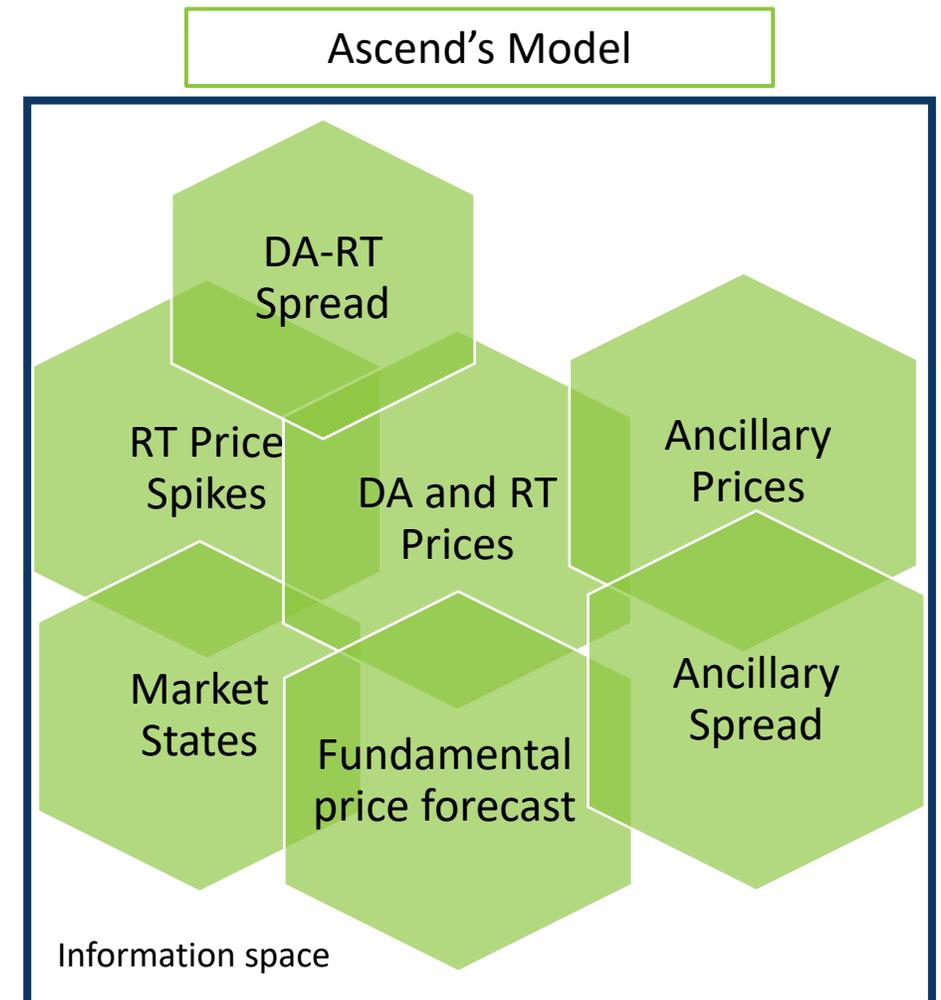
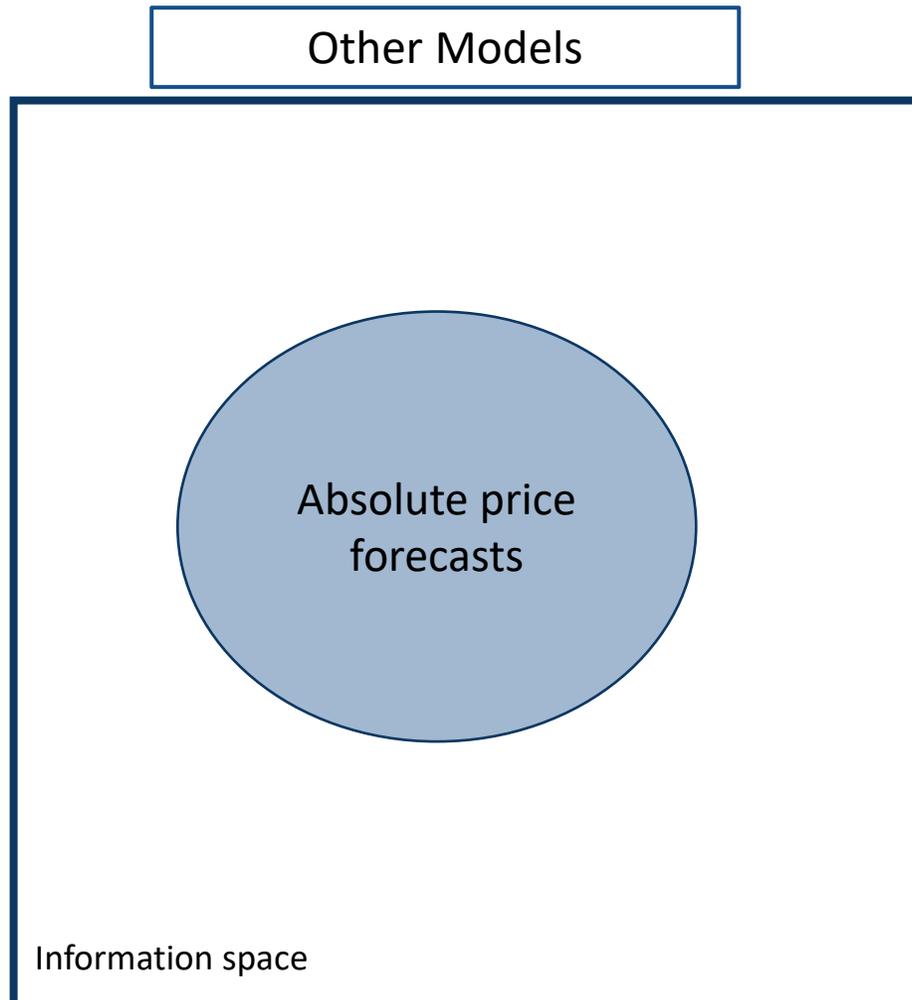
Probabilistic forecast of DA-RT

Novel strategy to make bidding decision



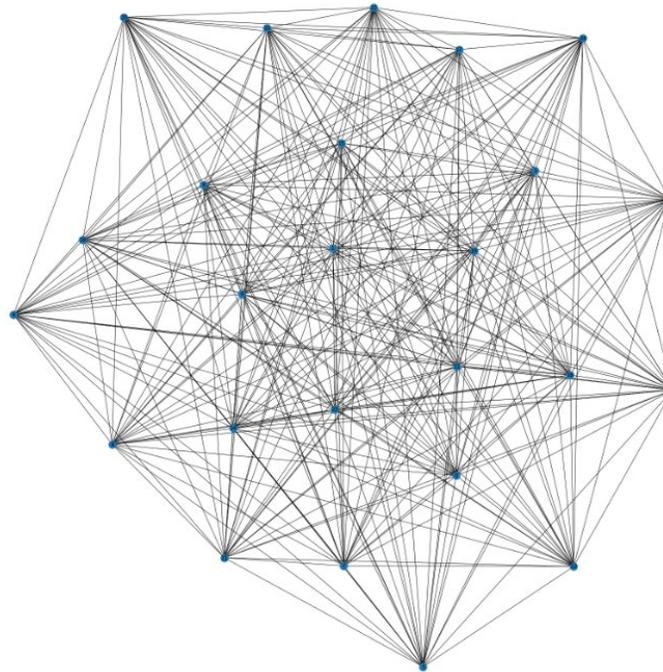
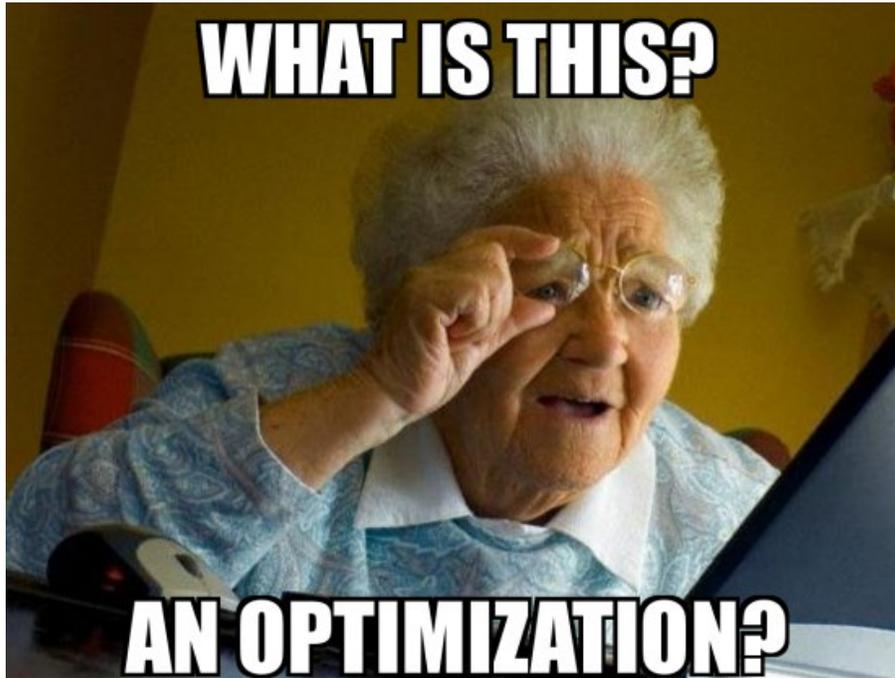
- Experiment on sample node over the last six months of 2022 shows the increase in the total revenue by **52%** over a simple lagged strategy that bids what was best on yesterday's prices.

Ascend's mosaic of models offers greater explanatory power



Optimization of Bids Across Ensemble Forecasting to Maximize Return and Minimize Risk

$$\max \left(\alpha * \sum_{model, product} (weight_{model} * price_{model, product} * dispatch_{model, product}) - \beta * GMAR \right)$$



Iterative neighborhood search algorithm, where the neighborhood changes dynamically with market conditions.

By avoiding already visited points, loops in new search trajectories and local optima can be escaped to:

- 1) Prevent the search from revisiting previously visited solutions,
- 2) Explore the unvisited areas of the solution space.



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