



GridBeyond™

Market Trends and BESS Optimization in ERCOT and CAISO



25th INTERNATIONAL CONFERENCE ON THE
EUROPEAN ENERGY MARKET
Lisbon, 27-29 May 2025 | Portugal

May 28, 2024
Ali Karimian, PhD

Summary

- Batteries as financial investments
- BESS Optimization
- What is alpha? Can we extend revenue optimization in equity investing to dispatching batteries?
- Recent market regimes in ERCOT and CAISO
- Examples of optimization from ERCOT and CAISO

- Integration of the battery bid optimizer with the OEM's software
 - Better **safety**
 - More **robust market participation**
 - Higher **alpha**
- Efficiency of operations: integration of bid optimizer with the QSE

- **Key Alpha Insight: Market complexity is increasing, creating opportunities for sophisticated traders to outperform basic strategies by 40-50%**



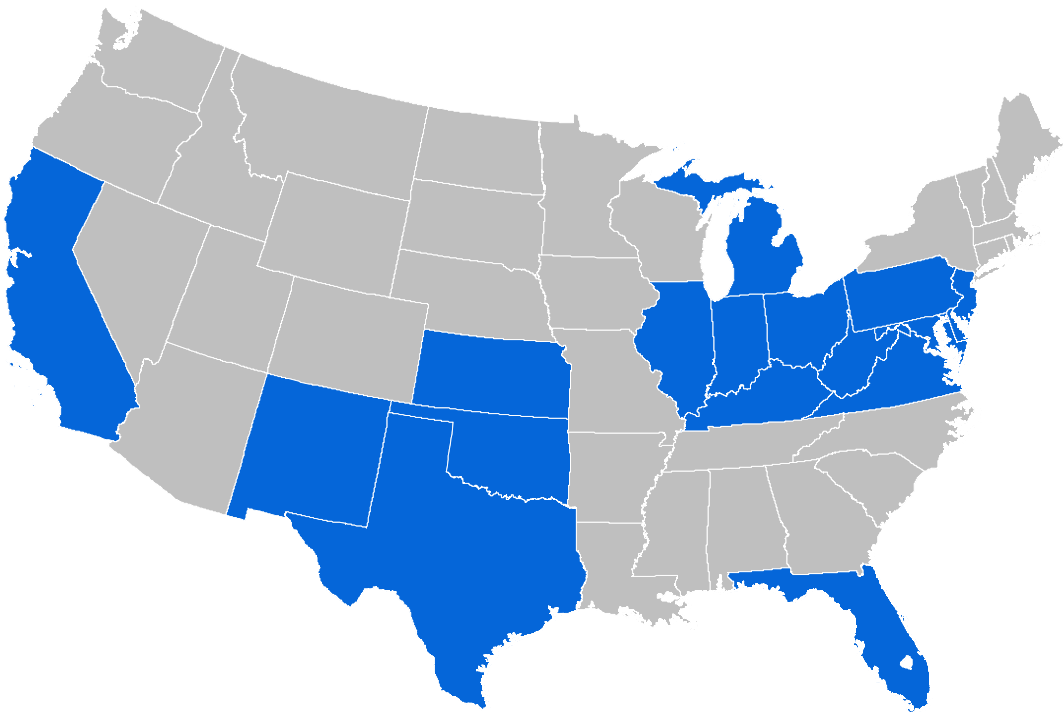
Ali Karimian, PhD
Market Optimization Director
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- Director of market optimization at GridBeyond in the past 2 years
- Prior work at Key Capture Energy, Constellation Energy, KKR and Axa Rosenberg.
- PhD in Electrical Engineering from UC San Diego and Masters in Financial Engineering from UC Berkeley.

About GridBeyond We Are

We Transform Energy Into Opportunity For The Entire Ecosystem

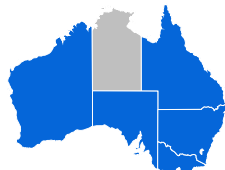
United States



Europe



Australia



Japan



Founded in
2010

Global

Offices in the US, Ireland,
UK, Australia, Japan

2.3GW

Load portfolio

1.3 GW

Of batteries under contract

160+

Employees

900+

Customers and partners

Partners:



RAINPOWER



CHIYODA
CORPORATION



Constellation.

Power Storage as a Financial Investment

- A BESS can be treated like **a long-short portfolio**, with many more regulatory and physical constraints.
- Short electricity when it is cheap.
- Long electricity when it is expensive.
- Provide ancillary services consistent with the SoC requirements such that revenue is maximized.
- Respect all physical and regulatory constraints.
- Play the interaction among different markets (such as the day-ahead and real-time markets).

Revenue Optimization – CAISO, Similar Extension to ERCOT

$$\text{Revenue}(h) = \text{Energy}(h) + \text{RUC}(h) + \text{AS}(h) + \text{Bid Cost Recovery} + \text{Flex ramp up/down}$$

↓
Paid to the RA holder

└──────────────────┘
Cannot optimize

- Energy revenue is the sum of DART and RT energy revenues:

$$\text{Energy Revenue}(h) = \underbrace{Q_{DA}(h) \times [P_{DA}(h) - \frac{1}{4} \sum_{fm \in h} P_{FMM}(fm)] + \frac{1}{4} \sum_{fm \in h} Q_{fm} \times [P_{FMM}(fm) - \frac{1}{3} \sum_{m \in fm} P_{RT}(m)]}_{\text{DART}} + \underbrace{\frac{1}{12} \sum_{m \in h} Q_{RT}(m) \times P_{RT}(m)}_{\text{RT energy}}$$

- Ancillary service payments are calculated based on the capacity payments, deployment and the energy market impact, and mileage payments for regup and regdown.

$$\text{AS}(h) = \text{Upward AS}(h) + \text{RegDown}(h)$$

α Generation, CAISO/ERCOT - cntd

$$\text{upward AS}(h) = \sum_{u,t} [\text{AS price}_u(h) \cdot Q_{u,t} + \text{DR}_{u,t} \cdot Q_{u,t} \cdot \text{RTD price}_t + M_{u,t}(h)]$$

- where AS price refers to the cleared price of each ancillary service in the day-ahead and FMM,
- u is over up ancillary services regup, spin, non-spin,
- t is over the 15 and 5 min intervals within hour h .
- $\text{DR}_{u,t}$ corresponds to deployment ratio of ancillary service u in interval t .
- RTD Energy_t corresponds to energy price in RTD time interval t .
- $M_{u,t}(h)$ is the mileage payment for ancillary u in time interval t . This payment is best estimated as:

$$M_{u,t}(h) = Q_{u,t} \cdot \text{Mileage}_{u,t} \cdot \sum_t \text{diff}_t(\text{deployment ratio}_{u,t})$$
 where $\text{Mileage}_{u,t}$ is the mileage payment \$/MW.

$$\text{RegDown}(h) = \text{Regdown price}(h) - \text{DR}_{\text{regd},t} \cdot Q_{\text{regd},t} \cdot \text{RTD price}_t + M_{d,t}(h)$$

- $M_{d,t}(h)$ is the mileage payment for regdown in time interval t , following similar calculation to $M_{u,t}(h)$ using the awarded regdown quantity, mileage price, and mileage multiplier for regdown.

What Goes into Successful Bid-Optimization?

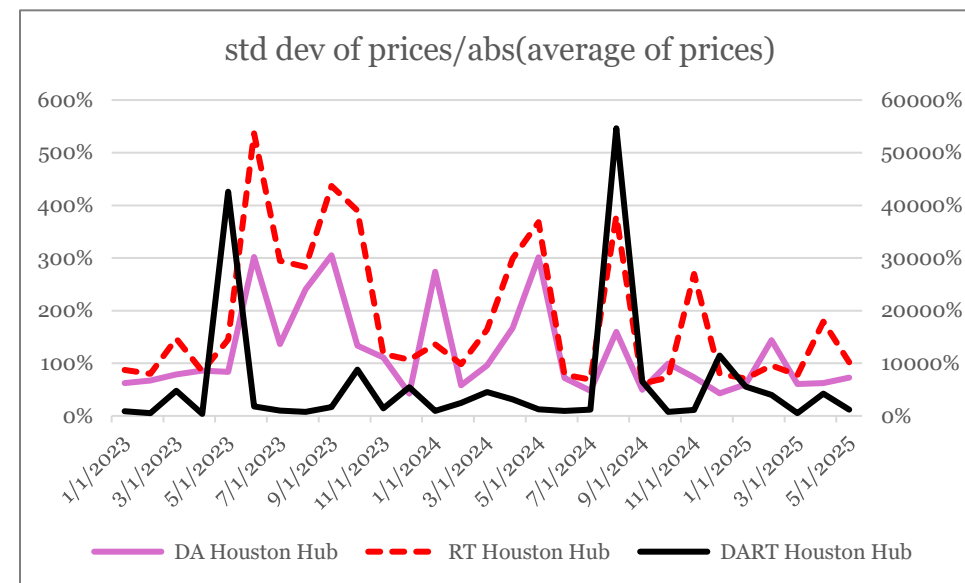
- Detailed understanding of ERCOT/CAISO regulations
- High-quality forecasts of energy and ancillary prices
- High-quality forecasts of the deployment of ancillary services
- Detection of market regimes
 - flexibility in daily cycle limits
 - Change of strategies
- Regulatory expertise → Alpha through compliant but aggressive bid strategies
- High-quality forecasts → Alpha through superior price, SoC and Ancillary Services deployment predictions
- Market regime detection → Alpha through adaptive strategy switching



Risk and α in the power market

- In the equity world:
 - Excess return over a benchmark (such as SP500), after adjusting for the first order risk (β)

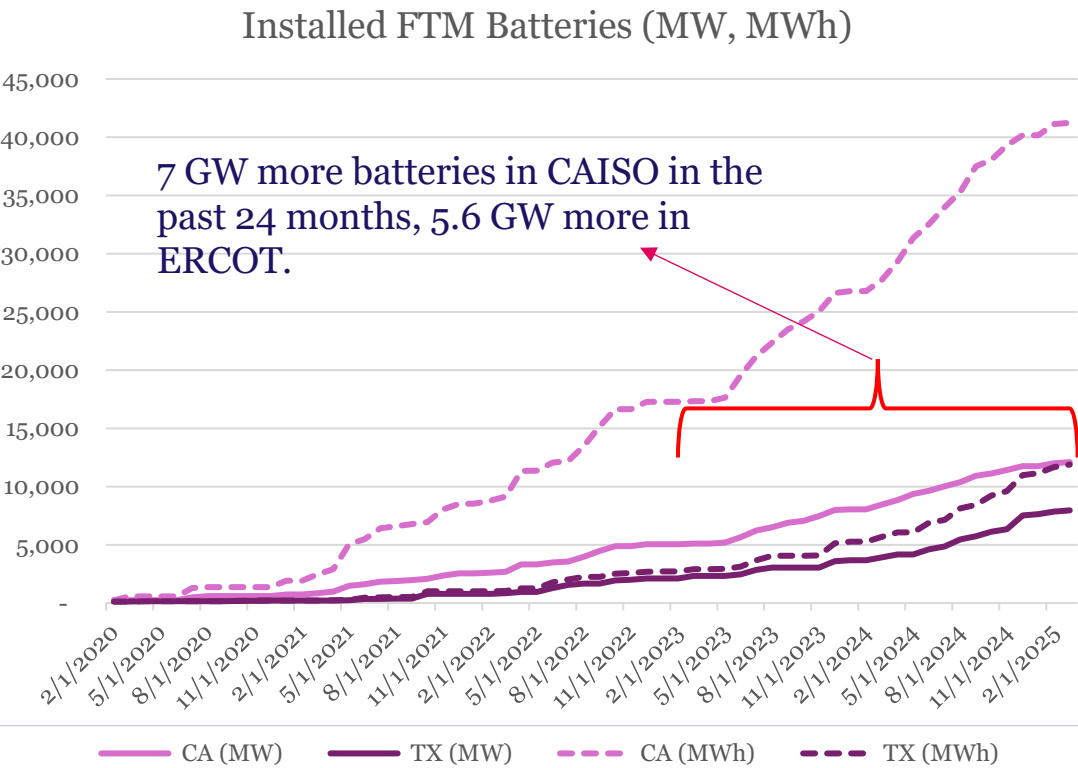
$$\alpha = r - R_f - \beta \times (R_m - R_f)$$
- Batteries act similar to a long-short portfolio. You charge (short) when
 - You charge the battery when power is (deemed) cheap,
 - Discharged when power is (deemed) expensive,
 - Can add financial settlements into the mix, such as DA/RT energy (the spread of the Day Ahead and Real Time energy prices)
- What batteries provide other than financial bets on DART?
 - Physical asset to hedge financial positions
 - Added revenue from ancillary services.
- What are the differences of optimizing a battery and an equity portfolio?
 - Benchmark is not passive** (more next slide).
 - Much higher vol in power market.
 - Returns of **batteries** are **not correlated** with the **equity** market.
 - Diversification benefit for investors.



Vol of DA and RT prices are shown on the left axis, and vol of RT on the right axis.

What Batteries are on the Grid?

- Due to higher battery installations, having better algorithmic trading matters more relative to 2023 and before.
 - RTC+B on batteries to be built in ERCOT: shorter durations.



Battery Duration distributions in TX, April 2025

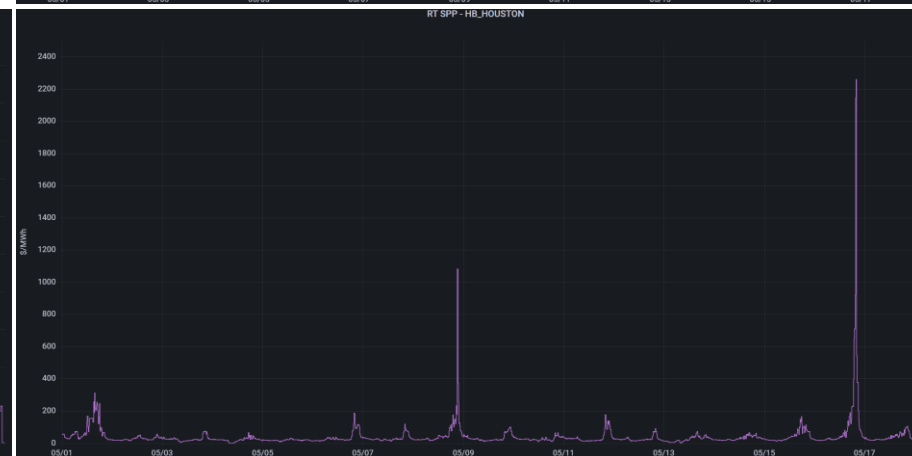
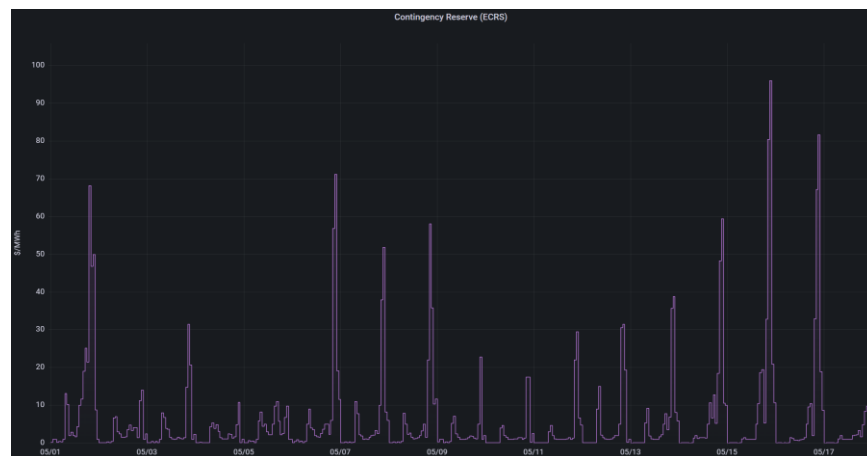
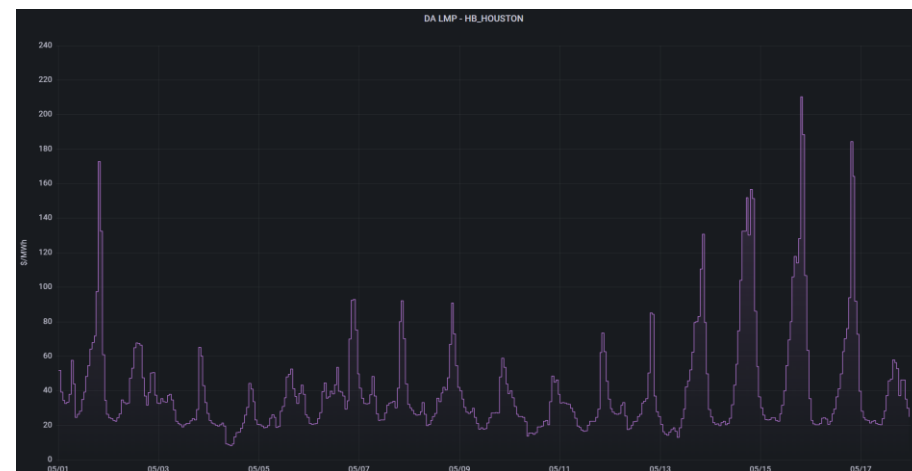
Durations	MW	%
Under 0.9	381	5%
0.9-1.1	3,184	40%
1.1-1.9	1,430	18%
1.9-2.1	2,091	26%
2.1-2.5	864	11%
Above 2.5	10	0%
Total	7,960	

Battery Duration distributions in CA, April 2025

Durations	MW	%
under 2	2,188	18%
2-3.9	959	8%
3.9-4.1	8,487	70%
4.1-4.5	31	0%
4.5-5	369	3%
above 5	69	1%
Total	12,104	

ERCOT – 2025

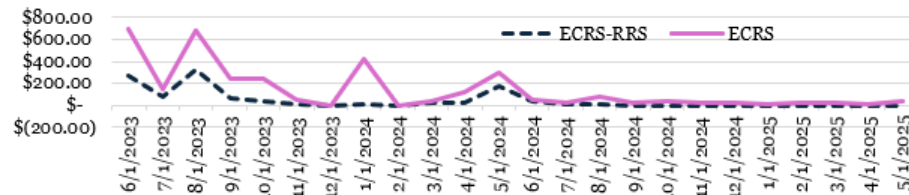
- More volatility when thermal outages are high.
- More recent RT energy price spikes after 9pm, even on weekends.
- DA-RT spread generally harder to predict than before.
- More value in RT energy during the evening peak, followed by DART spread throughout the day
 - **alpha.**
 - Better SoC management as other BESS run out of juice
- ERCOT currently procures energy in DA (hourly) and RT (5-min), and AS in the DA (hourly). After December 2025, both energy and AS will be procured in the DA (hourly) and RT (5-min).



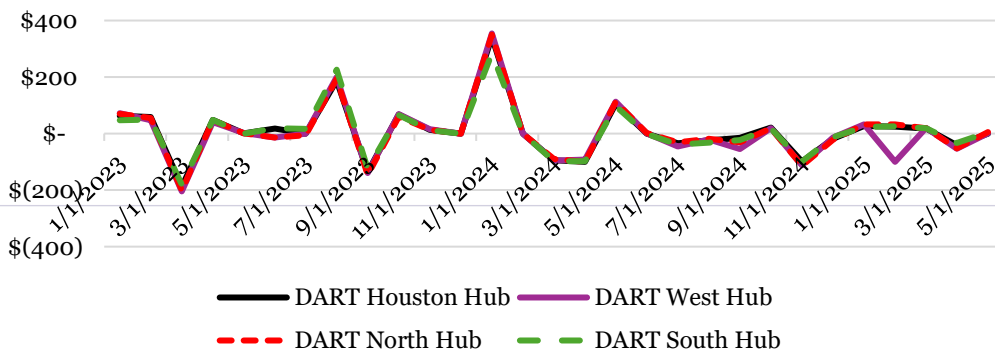
ERCOT – Past Few Years

- **Net load** + non-renewable outages **relatively flat** in the past two years, while **5.6 GW more batteries** have been **built** in TX, in the past 2 years.
- DA/RT energy and AS prices came down since 2023, while DA/RT and ECRS/RRS spread have been harder to predict.
 - Both DA/RT and ECRS/RRS spreads have been changing direction more frequently recently
- Generation is overbuilt as of Q2 2025 and AS market is saturated.
 - **Need sophisticated traders/algorithms to generate alpha.**

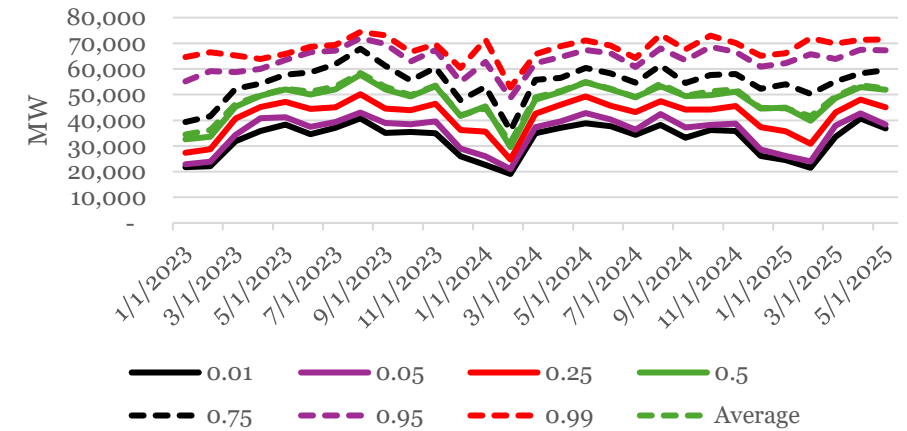
ECRS and the spread of ECRS/RRS when net load+outage in top 95%



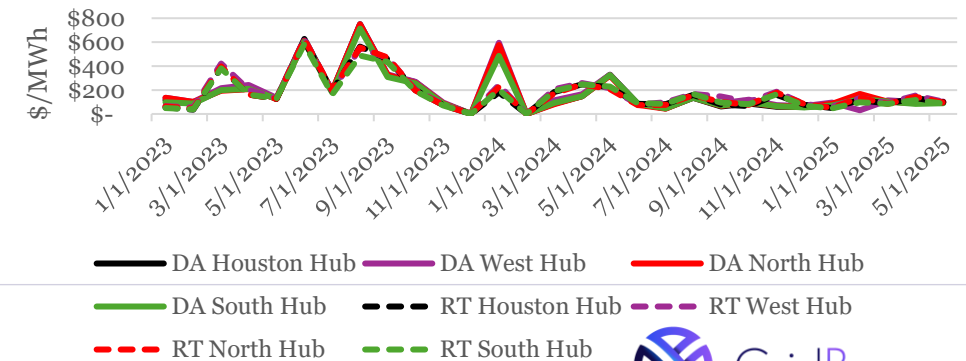
DART energy prices when net load+outage in top 95%



Various percentiles of Load - (solar and wind generation) + non-IR outage

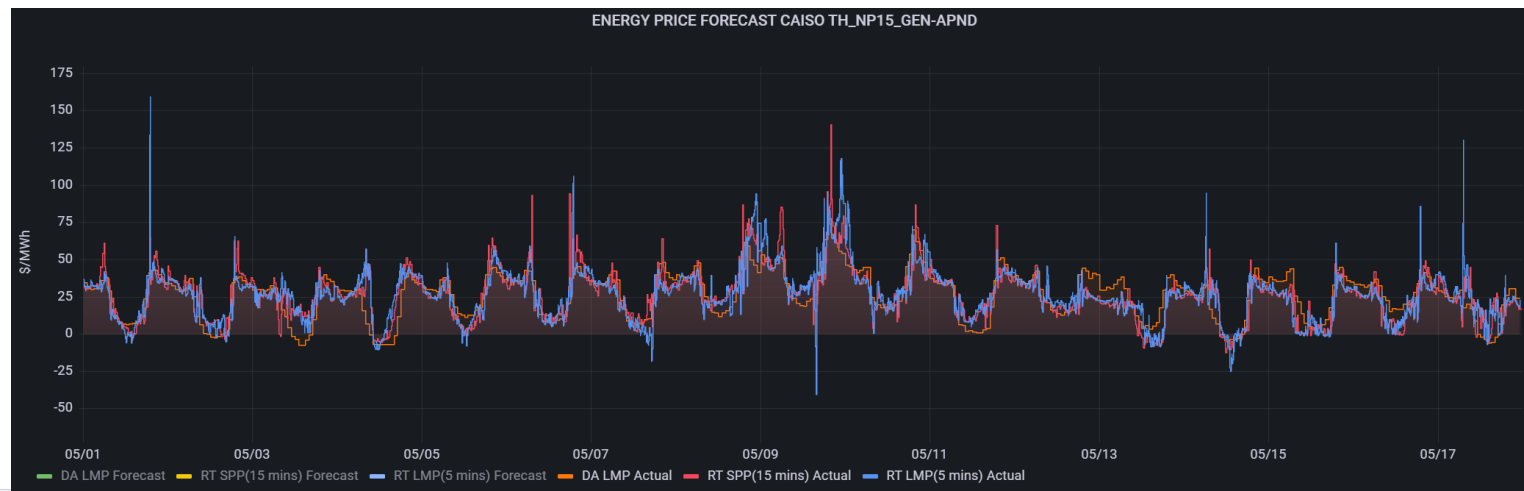
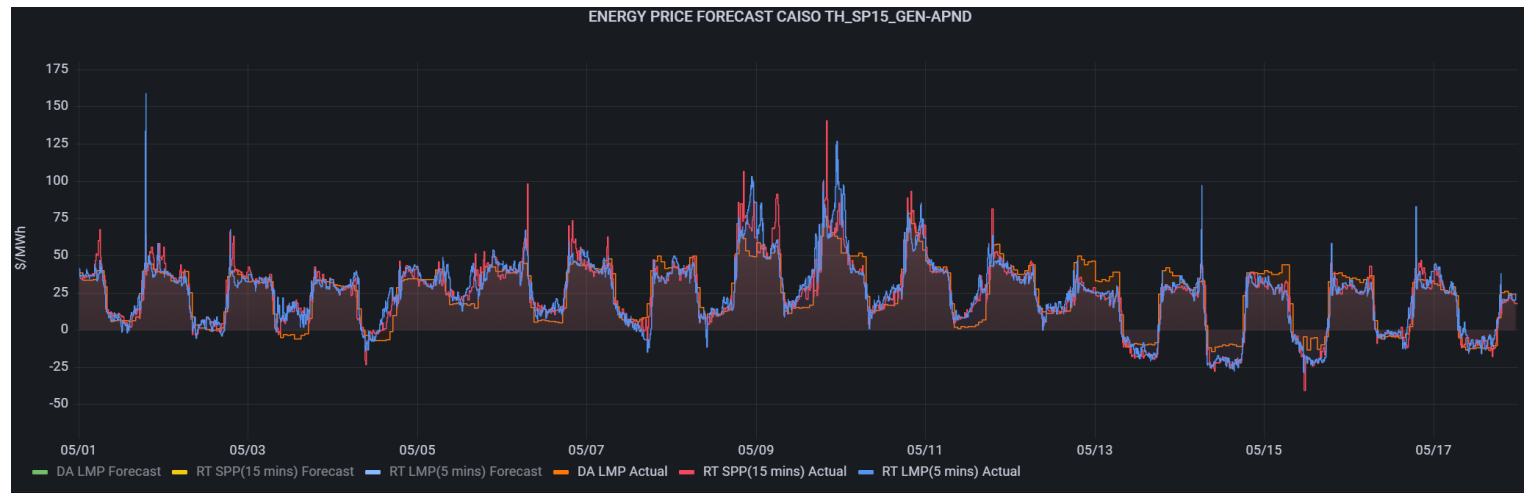


DA and RT average energy prices when net load+outage in top 95%



CAISO – 2025

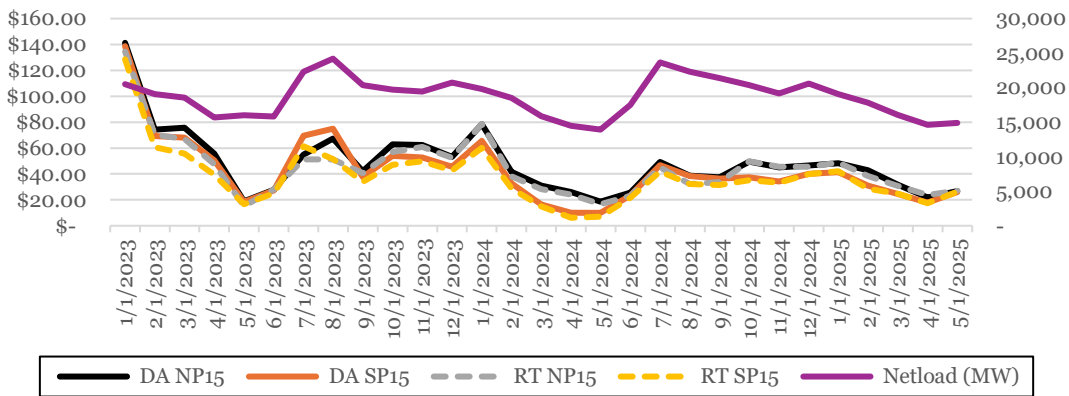
- CAISO energy prices generally follow block formations, especially in SP15 (Southern California), following the solar activity.
- Price climb is generally sharp in the evening (~1 hour) going from negative or near zero prices to peak prices.
- Price decline is generally ~2hrs in the morning.
 - Forecasting energy/AS prices, DA/RT spreads, and AS deployment ratios → produce α .
- CAISO procures AS and energy in the DA market (hourly), and in the RT (15 and 5 minutes).



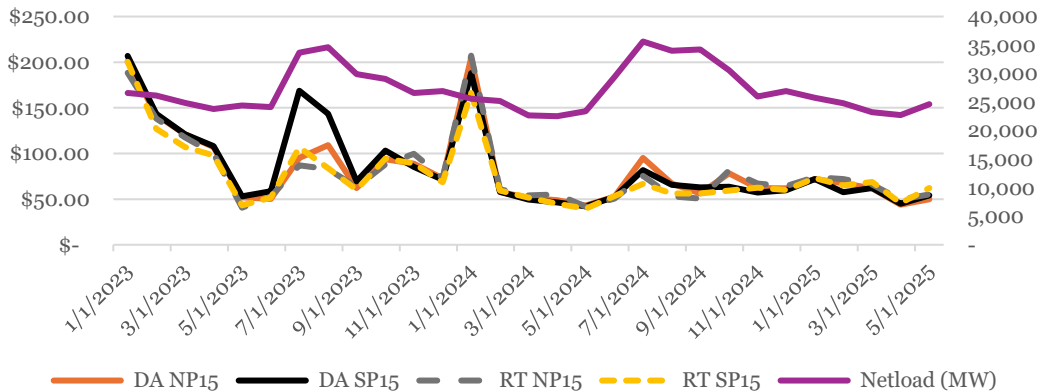
CAISO – Past Few Years

- Similar to ERCOT, DART spreads are less predictable relative to past.
- **Net load** has been relatively **flat** in the past two years, while **7 GW more batteries** have been **built** in CA, in the past 2 years → lower energy and AS prices.
- Challenging DART forecasting → capturing higher alpha for those who can forecast.

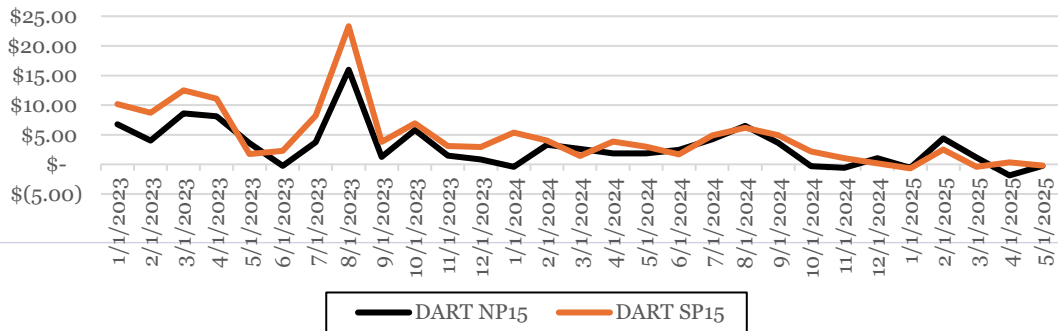
Average DA/RT prices and net load in CAISO



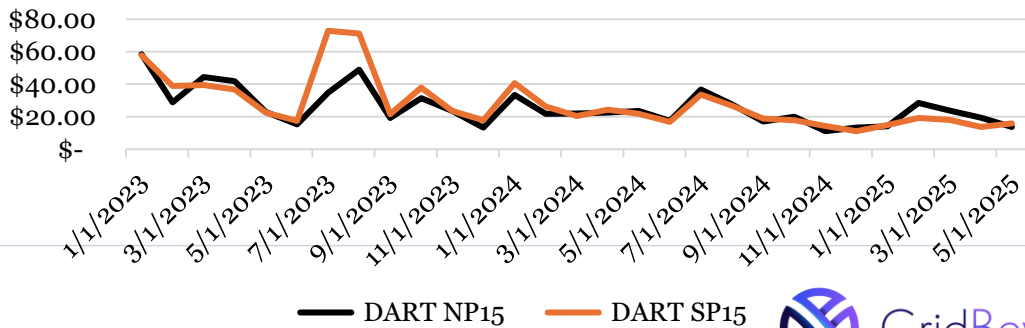
95 pct DA/RT prices and net load in CAISO



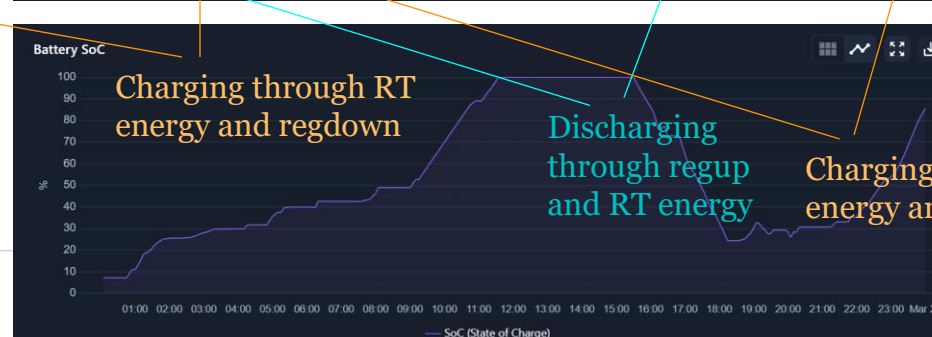
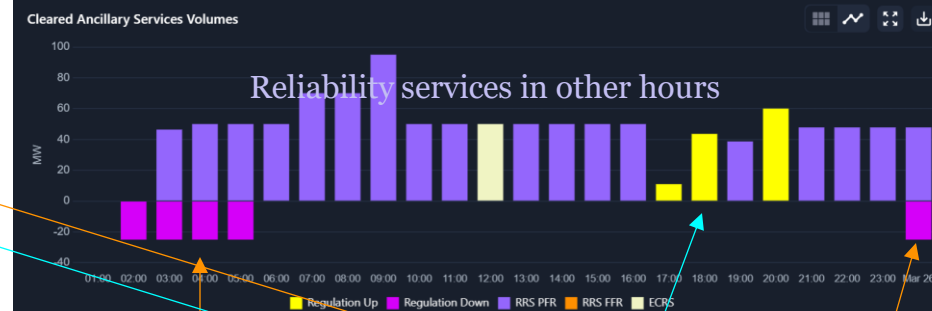
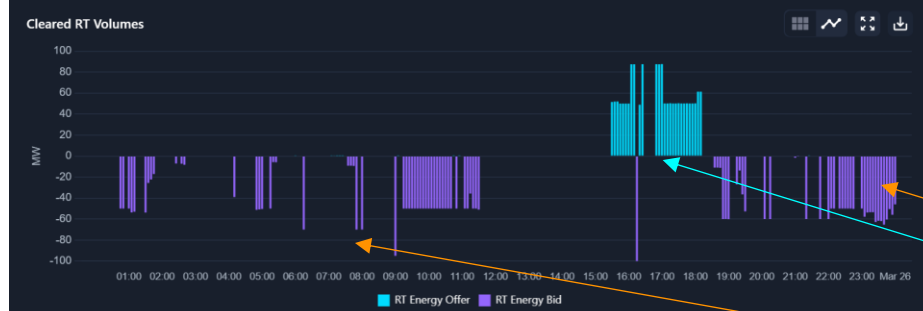
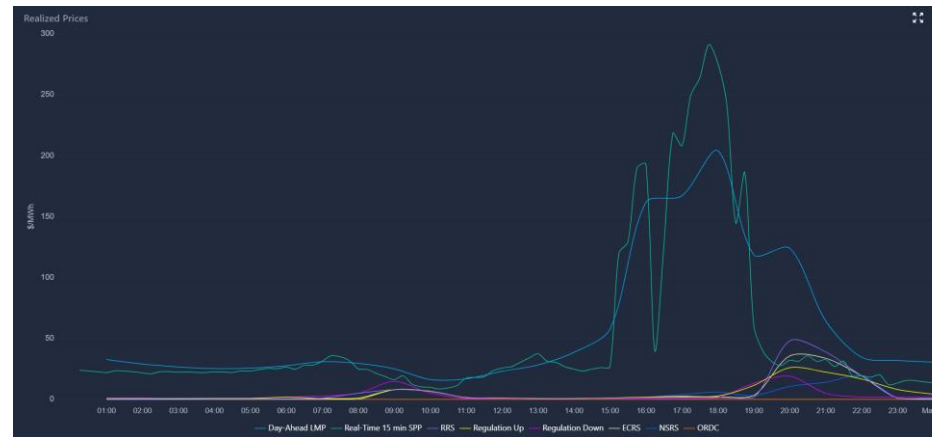
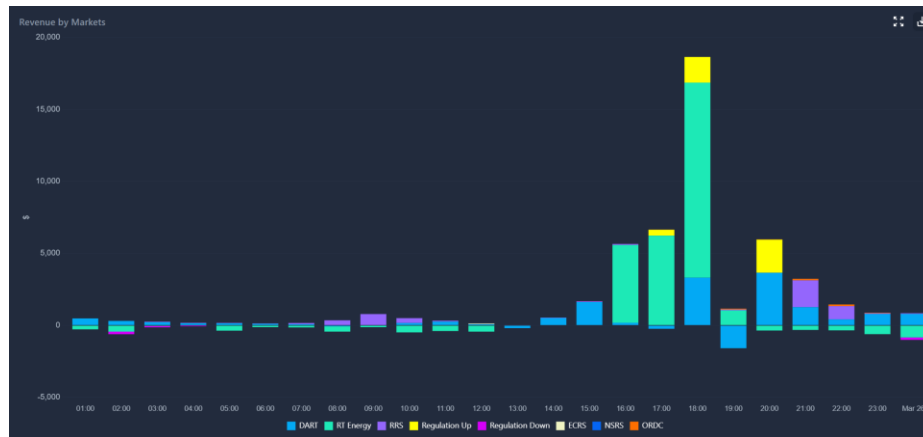
Average DA/RT price Spread



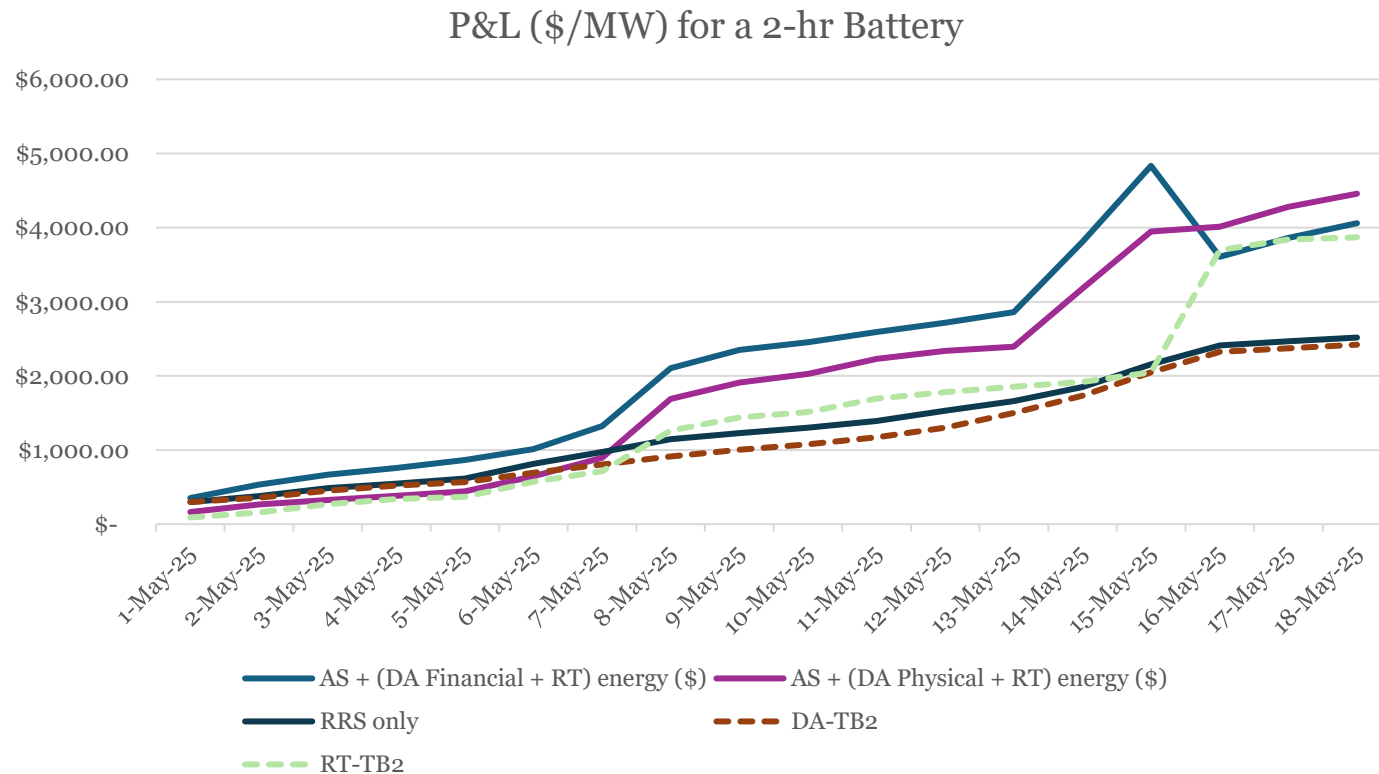
95 pct DA/RT price Spread



Example, ERCOT March 25 2025



P&L for various strategies, May 1–18 2025












- Higher expected P&L comes with higher daily volatility (notice the higher rise and fall of the strategy with financial DA energy).
- DA TB2 and RRS-only were close.
- RT TB2 had a jump on May 15th while strategies with DA energy did not perform well.
- One day is not the measure of success. It is the accumulation of performance that matters.

Integration of Bid Optimizer with OEM and QSE

- Complexities of alpha in real life:
 - Even best human/algo traders can't do much if their power storage resource doesn't perform well.
 - Project availability, reliability, and predictability of discharge/charge power are important.
- Integration of bid optimizer with the OEM software:
 - More flexible warranty → higher P&L when you need higher charge/discharge limits.
 - Higher reliability and predictable power
 - ☒ GridBeyond & OEM
- ☒ GridBeyond's Level 4 QSE / Scheduling Coordinator is in-house:
 - Helps with changing the bids/offers last minute if needed,
 - Direct interactions with the ISO (Q/A if needed)
 - One point of contact for all BESS market operations



Markets We are Active In (FTM Power Storage)

- ERCOT 
- CAISO 
- Japan 
- Ireland 
- UK 
- Australia 
- PJM 
- NYISO 
- ISO-NE 



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Optimization of BESS revenue/schedule:

- Integration of bid-optimization with the system hardware
- Including DA energy in the offer stack (ERCOT)
- Improving the forecasts of DA/RT prices and AS deployments



Appendix

α: Jan 1 – May 18 2025, ERCOT and CAISO

- In equities: beta is the ability to leverage the passive investment. Alpha is the rate of return beyond the leveraged passive investment.
- In **batteries**:
 - There is **no** real **passive** investment, as you deal with the project **availability** and deployment of ancillary services (which requires charging the battery back),
 - We cannot leverage up the passive benchmark,
 - Alpha is the accumulated daily P&Ls of the portfolio, in excess of the benchmark portfolio:

$$\alpha = \frac{\sum_d PnL(d) - \sum_d benchmark(d)}{\sum_d benchmark(d)} \quad , \quad \text{risk adjusted } \alpha = \frac{\alpha}{std(PnL(d) - benchmark(d))}$$

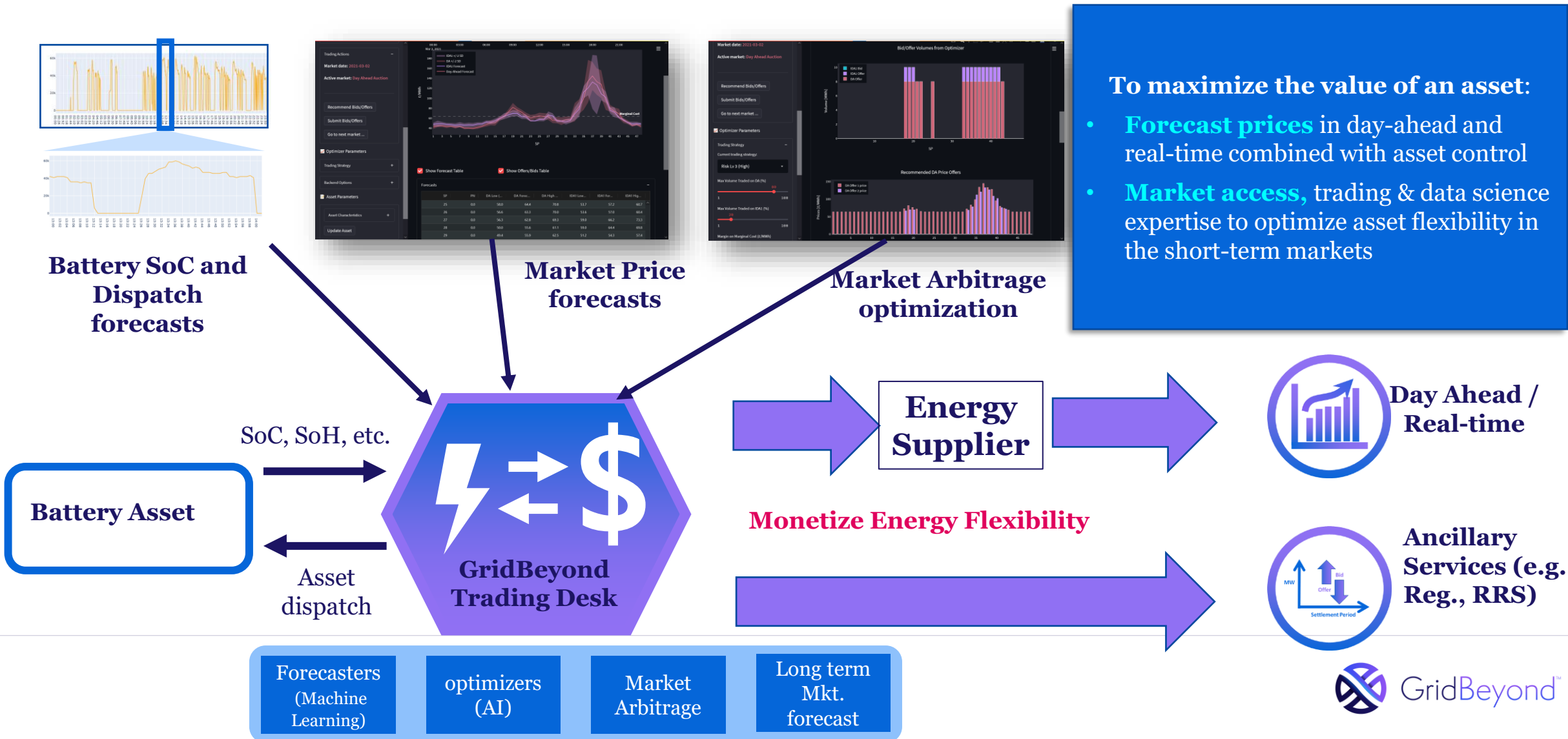
- ERCOT: the most passive benchmark is providing RRS (Responsive Reserve). 2-hr duration battery.
- In CAISO: the most passive benchmark is providing spinning reserve, followed by letting CAISO co-optimize DA energy. 4-hr duration battery

Strategy	alpha	Benchmark	risk adjusted alpha
RT Energy	44%	RRS	21%
AS + RT Energy	14%	RRS	10%
AS + (DA Physical + RT) Energy	100%	RRS	22%
AS + (DA Financial + RT) Energy	125%	RRS	27%

Strategy	alpha	Benchmark	risk adjusted alpha
AS + (DA+RT) Energy	6.58%	Co-optimized DA LMP TB4	7.9%
	1184%	Spinning Reserve	142%

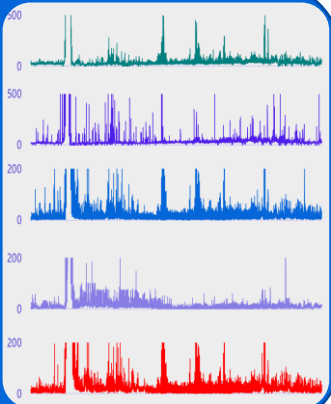
Trading as a Service (QSE / SC)

Maximise your BESS asset's return from merchant markets: Ancillary Services, Day Ahead, Real-time, RA

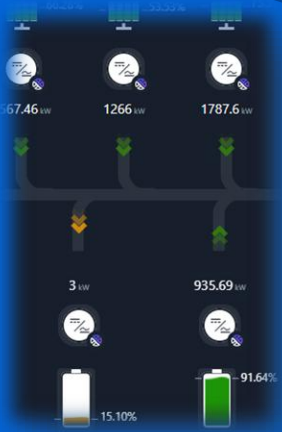


GridBeyond Services in North American Markets

Long-term
Revenue
Consulting



Energy
Management
System



Trading as a
Service (QSE /
SC)



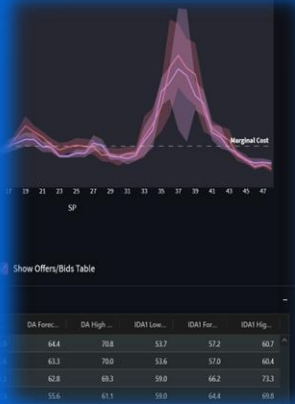
Short-term
Nodal
Forecasting



Virtual Power
Plants & Demand
Response



Bid Optimization
Software



Forecast

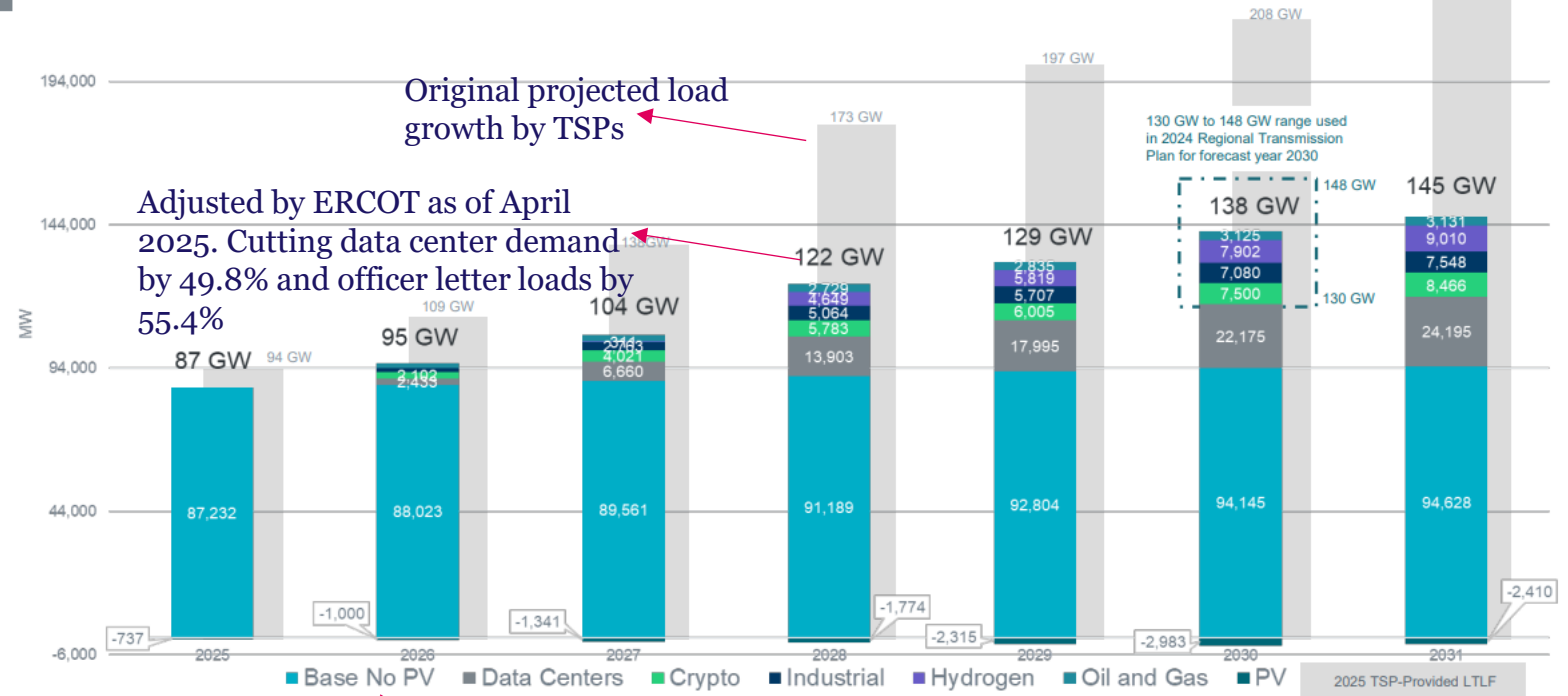
Control

Optimize

Future α: Load Growth and Opportunities

- Original load growth projections were hyped. Still high load growth projections after adjustments.
- Slowed generation project planning/development** due to
 - uncertainty in
 - IRA incentives,
 - Import tariffs impacting battery container/cells,
 - Texas senate bill SB388,
 - High cost of financing,
 - high cost of developing gas and nuclear thermal power plant.
- Soon** (maybe 2 years) load growth will catch up with slower generation development → **back to high price volatility.**

2025 ERCOT Adjusted Load Forecast Breakdown by Type



Key Takeaway: After adjustments, Data Center Load remains the largest growth by type.



Base load (including EVs, minus rooftop PV)

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