FRACTAL EMS

Where Along the Optimization Pathway Could You Be Losing Money?

Fractal EMS Inc.

The following tools help developers and owners maximize investments in storage

PROJECT LOCATION	PROJECT MODELING	CONTROLS	MONITORING / O&M	BID OPTIMIZER	ANALYTICS
Identify locations with line capacity that have existing or forecasted volatility.	Technoeconomic tool that maximizes project value that balances CAPEX, OPEX and revenue	Vertical controls platform that includes software, controllers, and integration	Real-time human monitoring and asset management, including remote troubleshooting and system restoration	Optimize between revenue and costs, then submit offers automatically to the QSE.	Tools that identify anomalous batteries, predict equipment failures and create automated reports
1	2	3	4	5	6

DEVELOPMENT

OPERATIONS

Software Stack

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BatterySIMM BatteryOS PowerDev	Fractal Model Ascend Analytics	Fractal EMS Wartsila GEMS Fluence Nextera	Fractal O&M Novasource	Fractal Optimizer Autobidder Tenaska CES	Fractal Reports Twaice Voltaiq

DEVELOPMENT **OPERATIONS**

Location/Procurement:

- Nodal vs hub volatility
- Self-integration vs traditional integrator

Availability:

- Causes of downtime
- 95% vs 98%

Warranty Optimization:

- Sizing (MW / MWh) and augmentations
- Business model / revenue stack (365 cycles/yr vs reality)

Long-term Health:

- Prolong the lifetime
- Avoid fires

Bid Optimization:

- Market revenue: Baseline vs reality
- Breakeven

Location/Procurement: +2%

- Nodal vs hub volatility
- Self-integration vs traditional integrator

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Location/Procurement: +2% / -5.5%

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Availability: +0.4%

- Causes of downtime
- 95% vs 98%

Warranty Optimization:

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Availability: +0.4%

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- 95% vs 98%

Warranty Optimization: +1.3%

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- Sizing (MW / MWh) and augmentations
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Long-term Health: +0.6%

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Pre-COD

Long-term Health: +0.6%

- Prolong the lifetime
- Avoid fires

Bid Optimization: +2%

- Market revenue: Baseline vs reality
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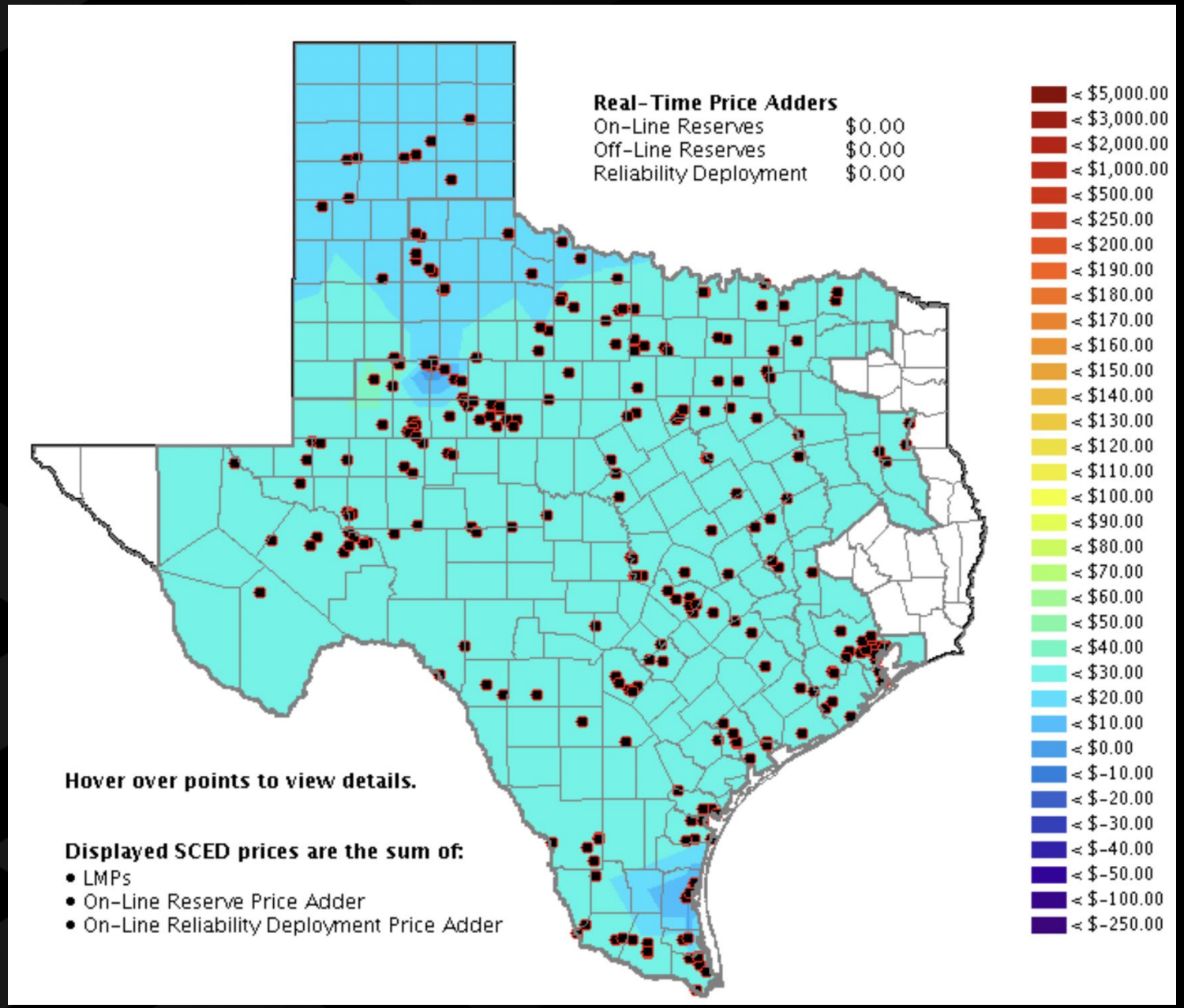
Post-COD

Location (+2%)


Real-Time Price Adders
On-Line Reserves $0.00
Off-Line Reserves $0.00
Reliability Deployment $0.00
< $5,000.00
< $3,000.00
< $2,000.00
< $1,000.00
< $500.00
< $250.00
< $200.00
< $190.00
< $180.00
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< $110.00
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< $70.00
< $60.00
< $50.00
< $40.00
< $30.00
< $20.00
< $10.00
< $0.00
< $-10.00
< $-20.00
< $-30.00
< $-40.00
< $-50.00
< $-100.00
< $-250.00
Hover over points to view details.
Displayed SCED prices are the sum of:
• LMPs
• On-Line Reserve Price Adder
• On-Line Reliability Deployment Price Adder

Availability (+0.4%): Causes of Downtime

Internet

Most internet is only 98% available, some offer 99% SLA's, but it's often difficult to find reliable internet in remote locations → mitigate by using several sources (e.g., two land lines and two cell modems)

Inverters

Inverters are one of the lowest cost components, but they cause an outsized amount of site downtime. Paying for higher quality inverters or having a large spare parts inventory will pay dividends.

Thermal Management

Thermal management works well…until it doesn't. Adjusting an air cooled system can delay COD, while replacing proprietary liquid cooled equipment will be a risk.

Fire System

Many fire systems have accidentally discharged. This has resulted in lost equipment and has caused sites to lose revenue.

EMS / Batteries

These are lower risks, but can be painful to repair.

Availability (+0.4%): Causes of Downtime

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95% vs 99% Availability (+0.4%)

Cheap inverters and cheap thermal management → 95% Availability → 15.7% IRR

Battery hard cost	**$125,755,154**	**314.39**	**$/kWh**
Dev Fee	$0	**0.00**	$/kW
Total capitalized ITC eligible costs	**$125,755,154**	**314.39**	**$/kWh**
Network Upgrades, not ITC eligible	$0	**-**	$/kW
Battery soft cost, not ITC eligible	$1,000,000	**10.00**	$/kW
Total battery cost	**$126,755,154**	**316.89**	**$/kWh**

25% more expensive inverters and thermal management (1.5% CAPEX) → 99% Availability → **16.1% IRR**

Battery hard cost	**$127,680,379**	**319.20**	**$/kWh**
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Payback: 2.5 years

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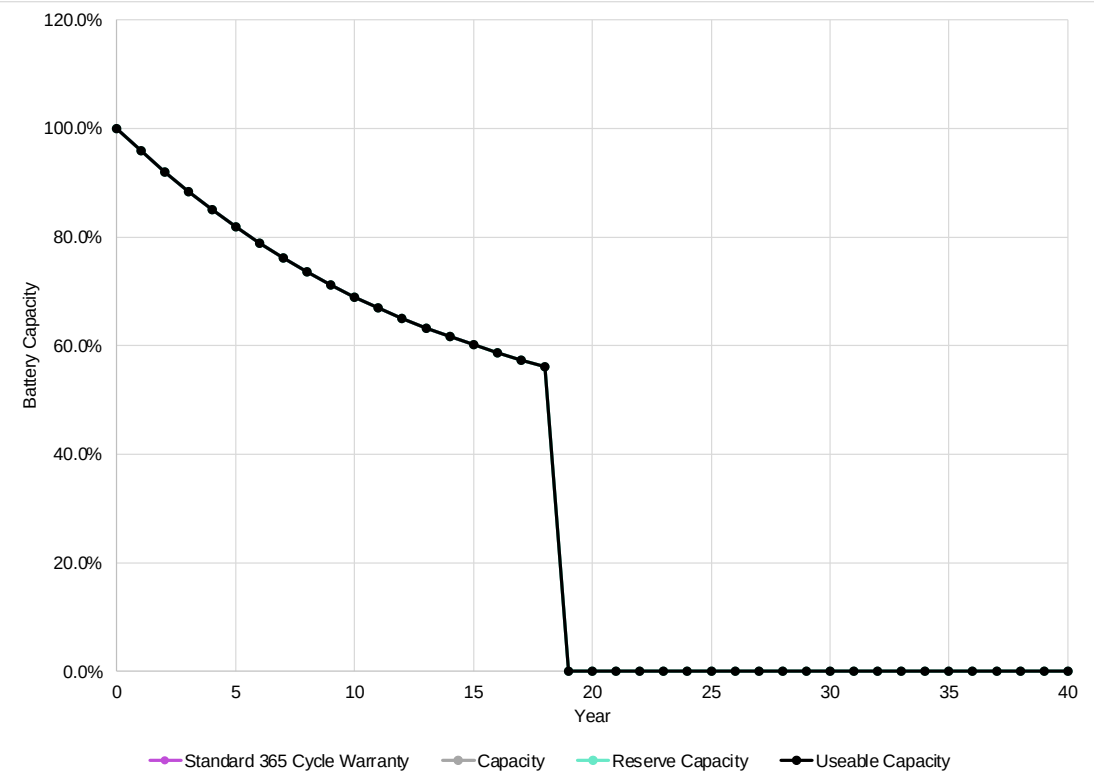
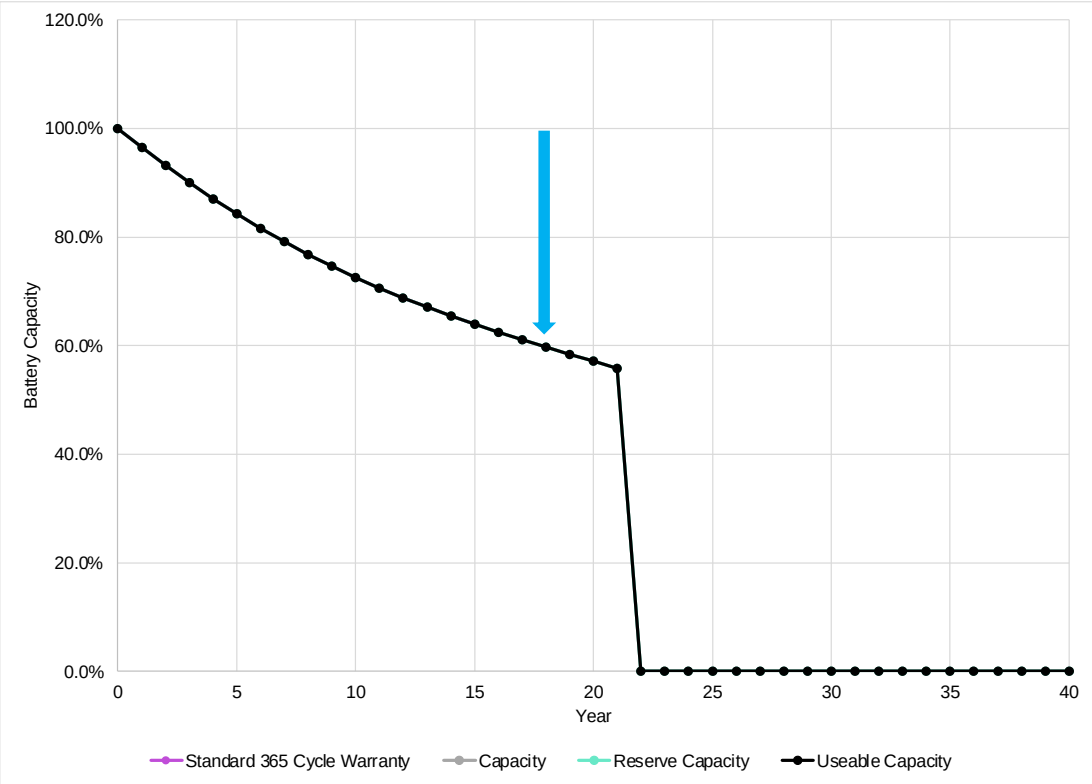
Availability Performance Guarantee @ 1.3%/yr of equipment → 98% Availability → 14.3% IRR (-1.4%)

Warranty Optimization (+1.3%)

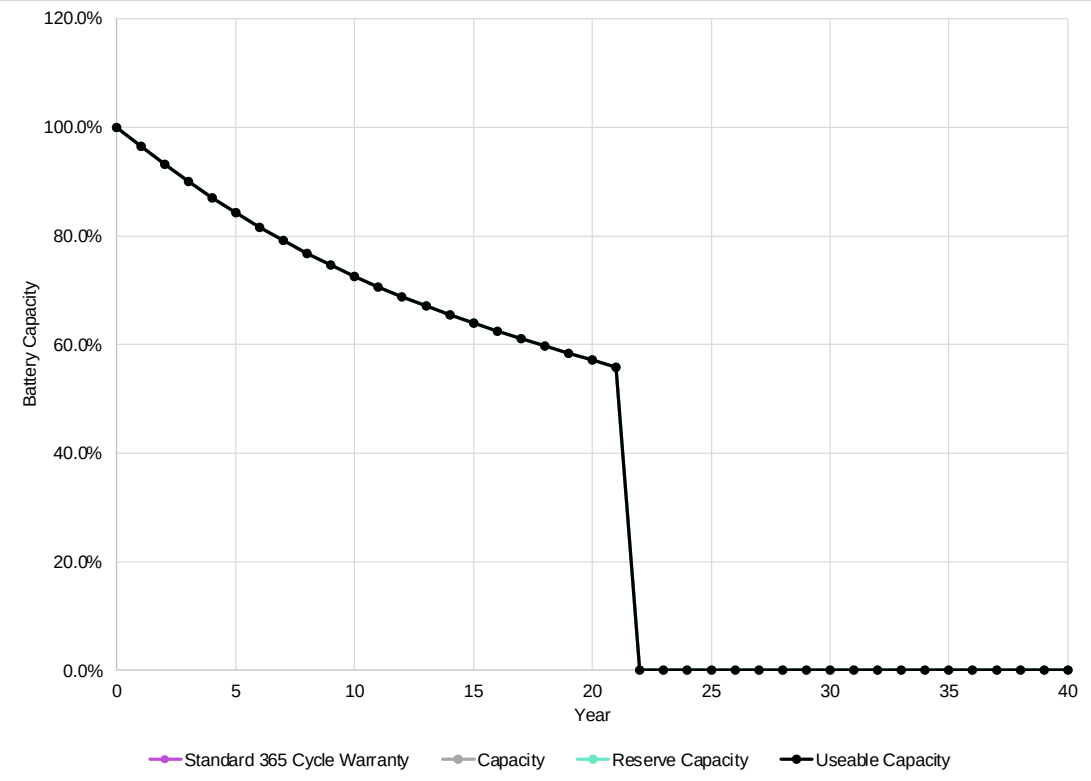
25% more expensive inverters and thermal management → 99% Availability → **365 cycles** per year → 15.2% IRR



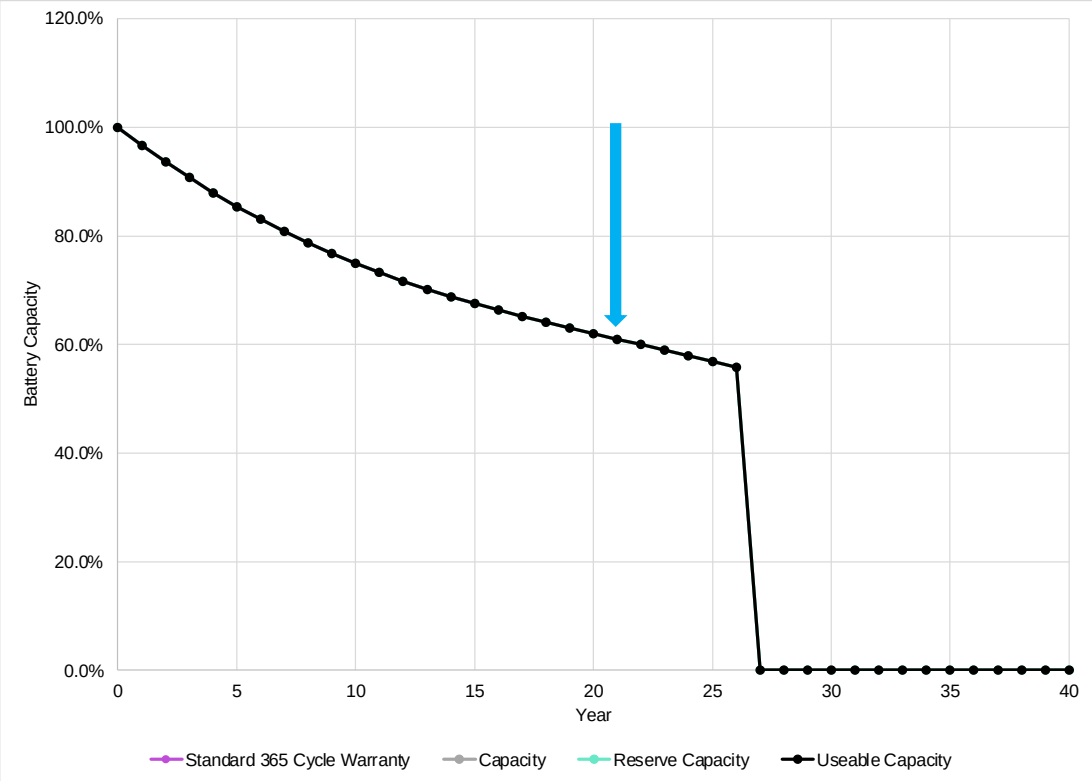
25% more expensive inverters and thermal management → 99% Availability → **300 cycles** per year → 16.1% IRR



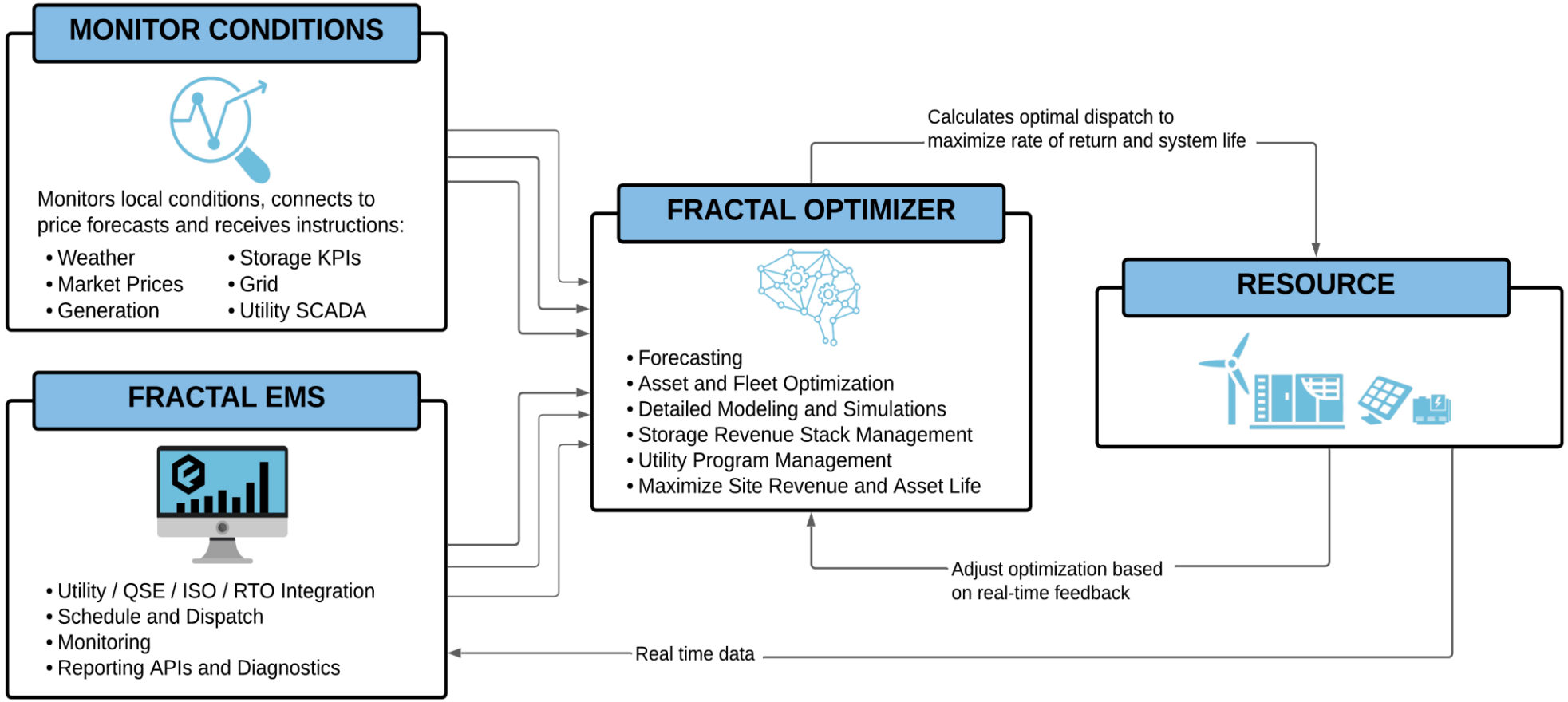
25% more expensive inverters and thermal management → 99% Availability → 300 cycles per year → **50% rSOC** → 21 yr → 16.1% IRR



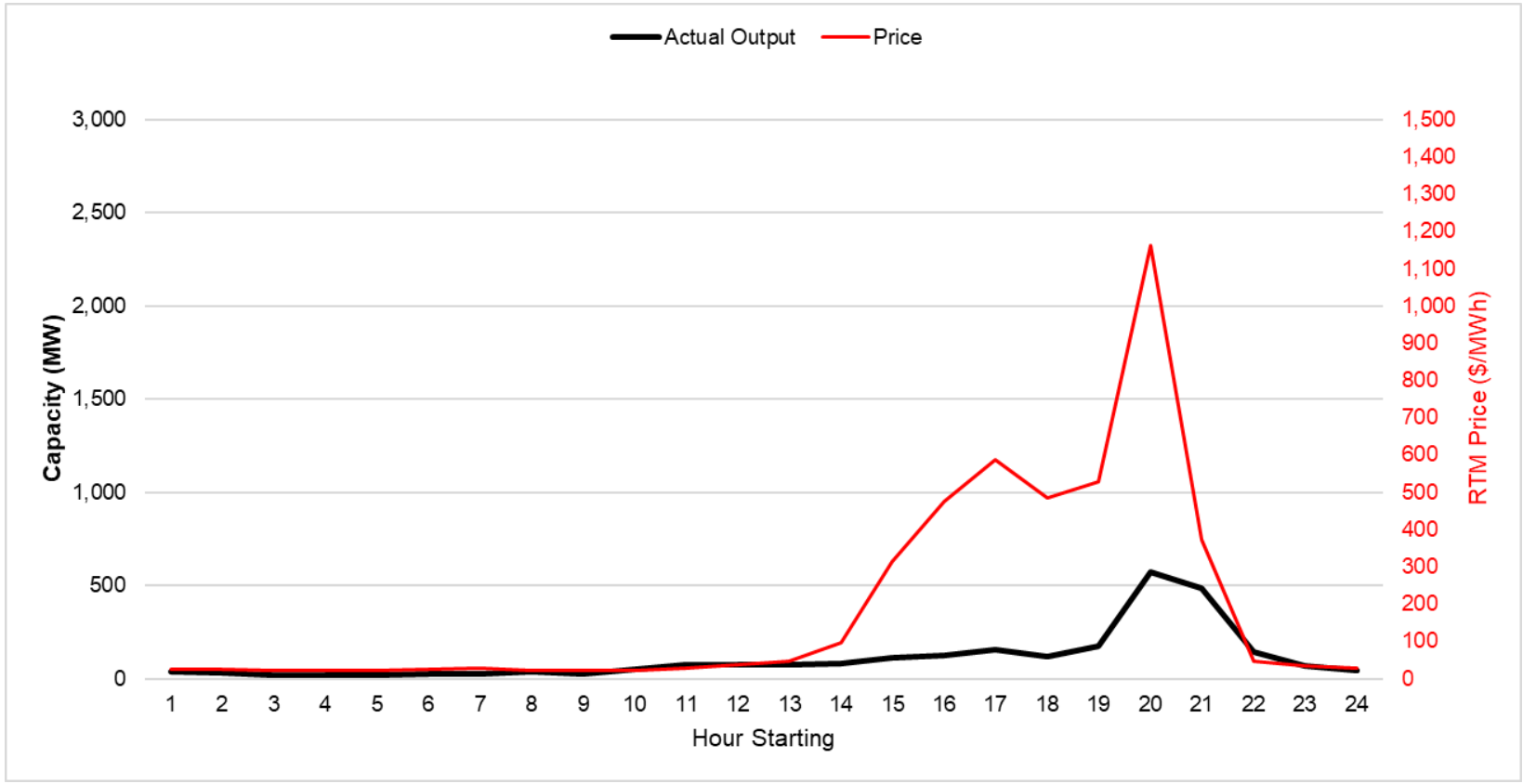
25% more expensive inverters and thermal management → 99% Availability → 300 cycles per year → **25% rSOC** → 26 yr → 16.7% IRR



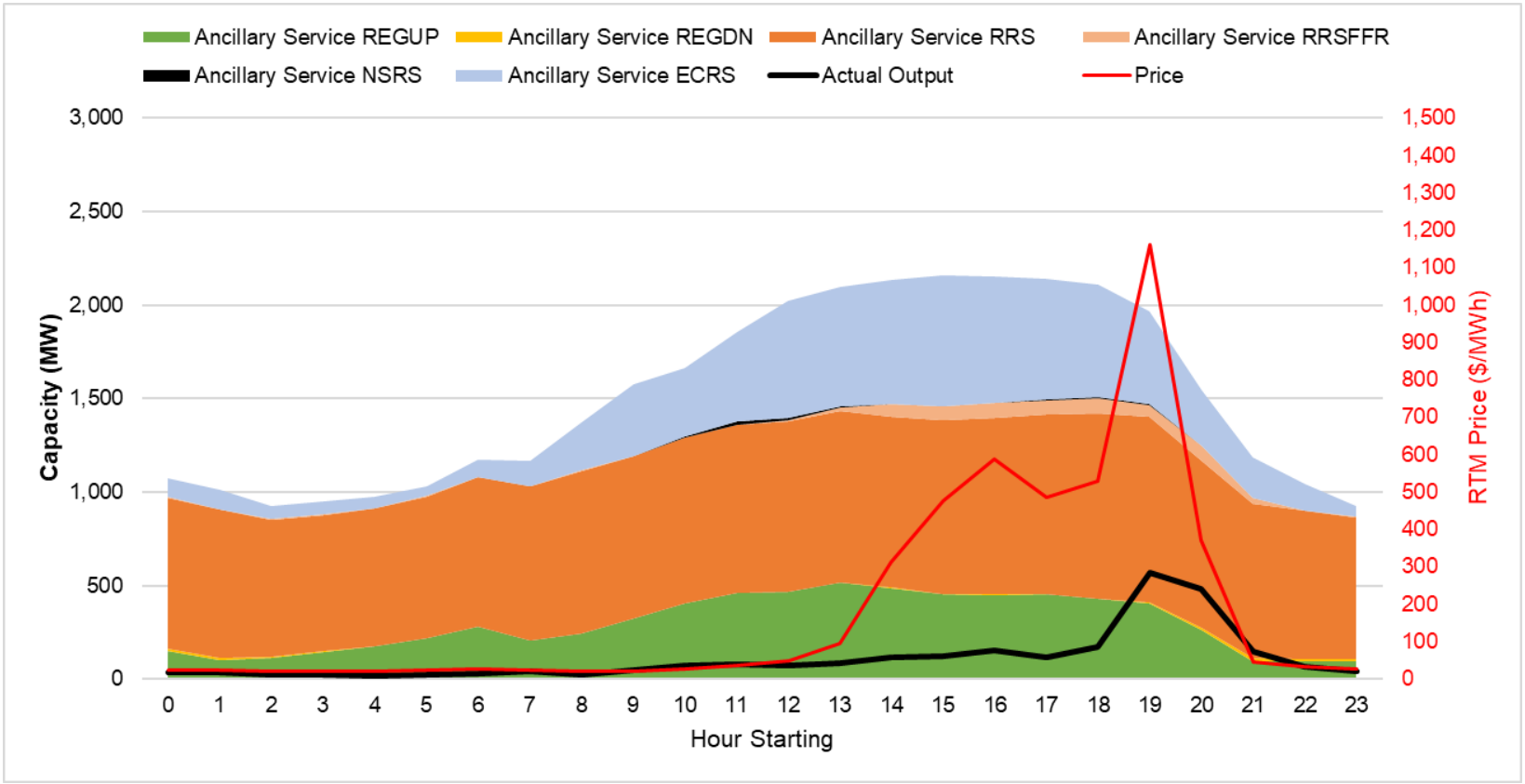
Bid Optimizers use a combination of price forecasts and proprietary machine learning methods to generate market schedules that maximize profitability, while accounting for costs (losses, degradation and auxiliary loads).



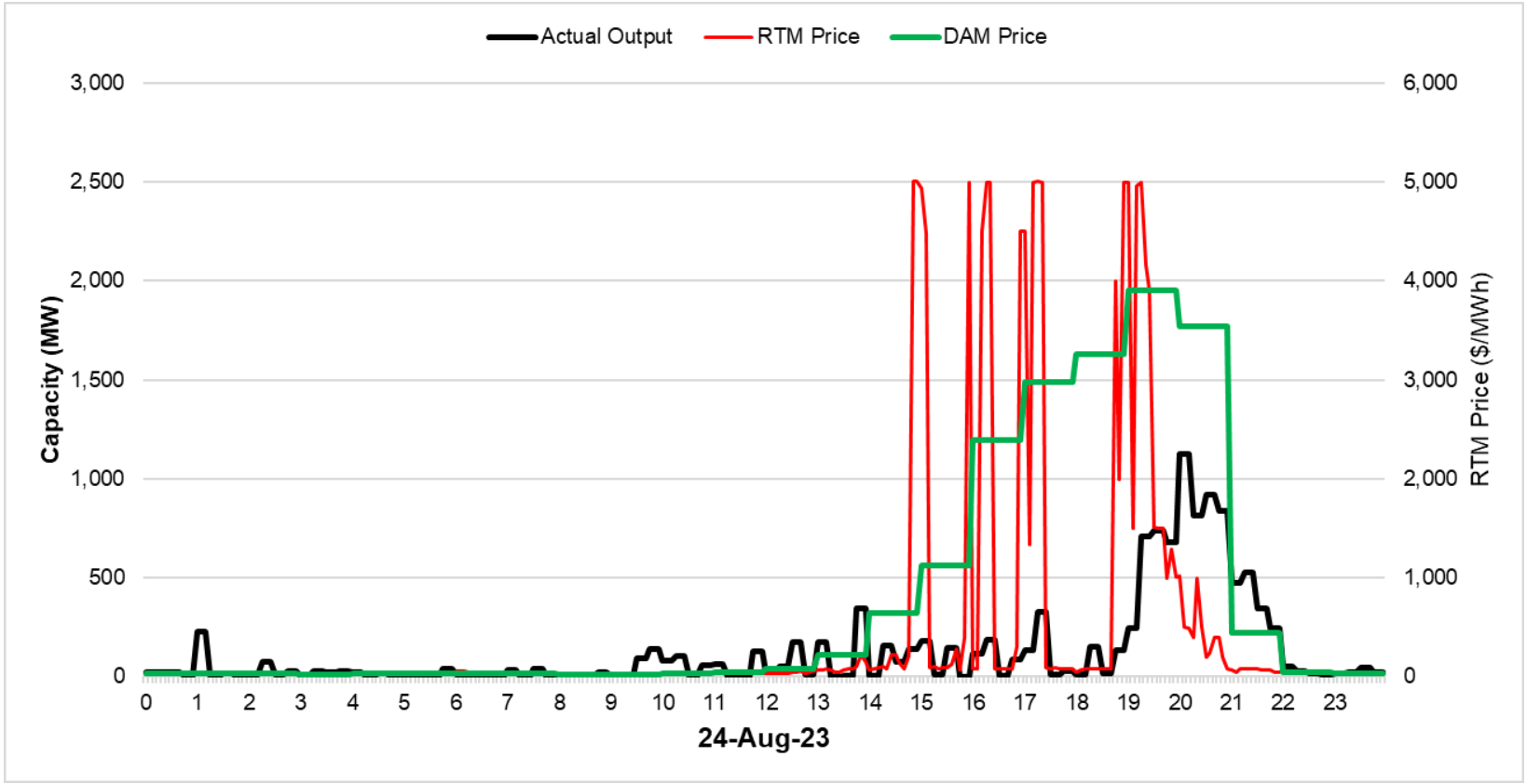
August 2023: ERCOT Battery output **closely followed the average energy price**.



August 2023: But Day Ahead Ancillary Services far exceeded energy market participation.

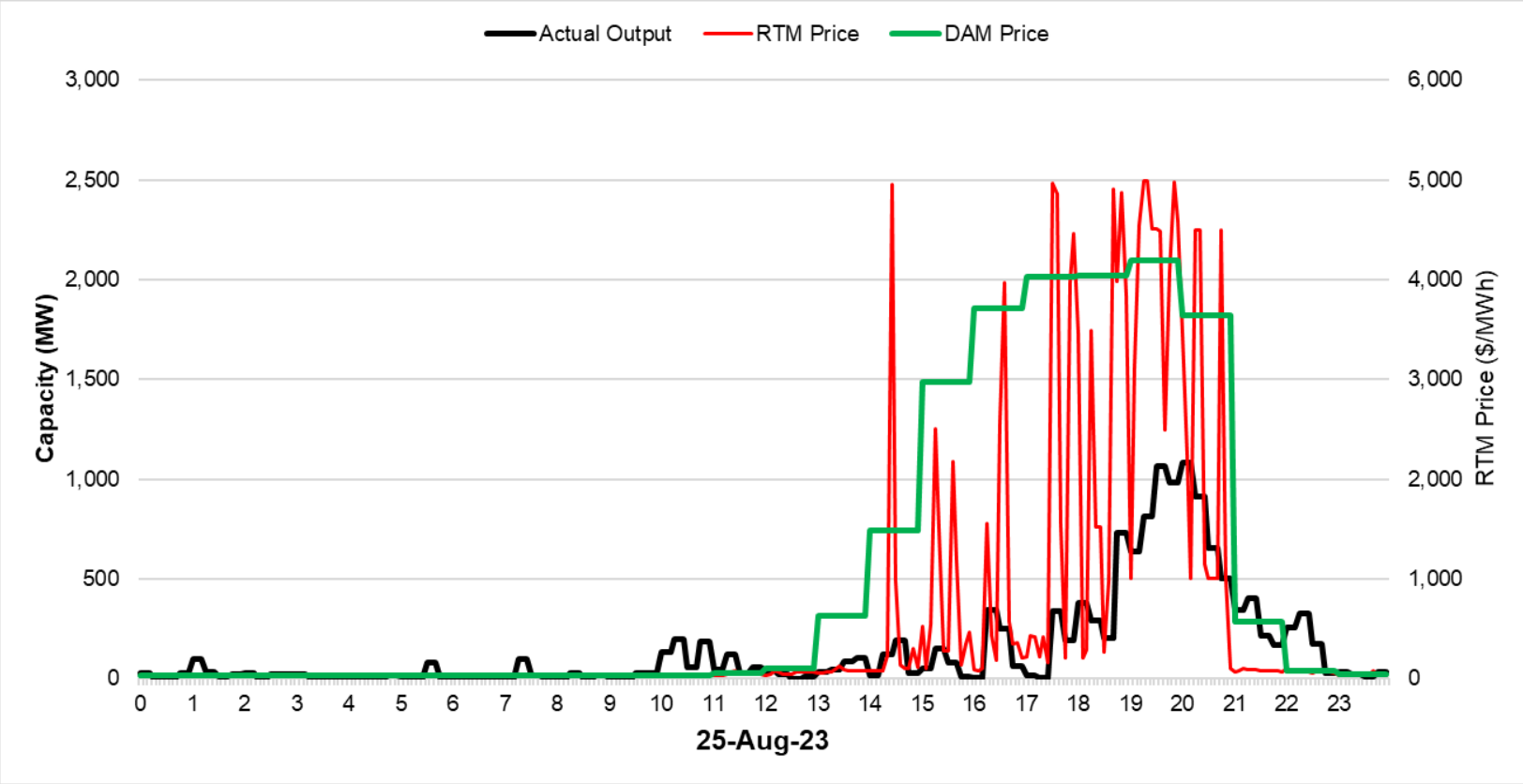


August 2023: Batteries missed the energy price peaks when peaks were outside typical hours.

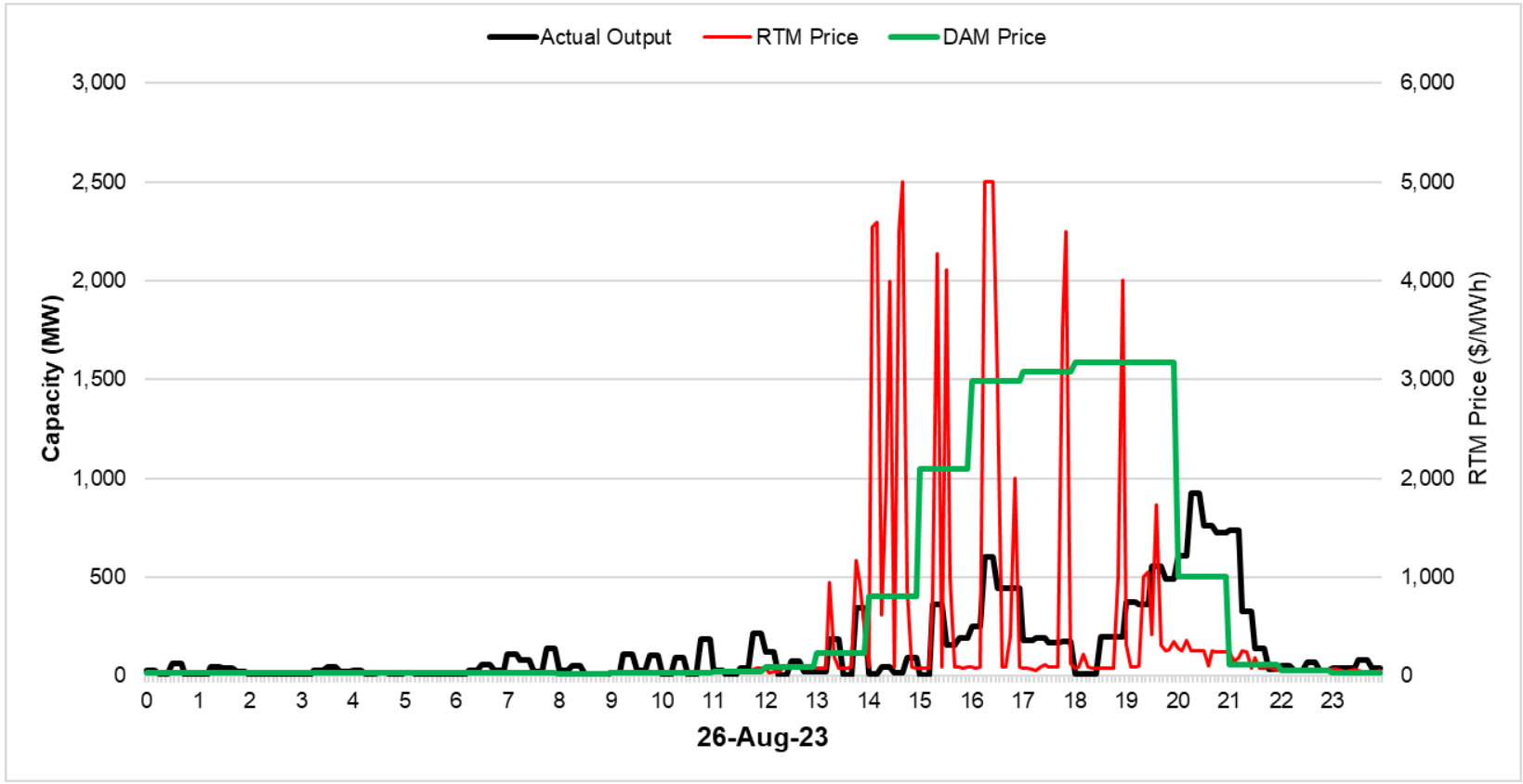


Bid Optimization (+0.3%)

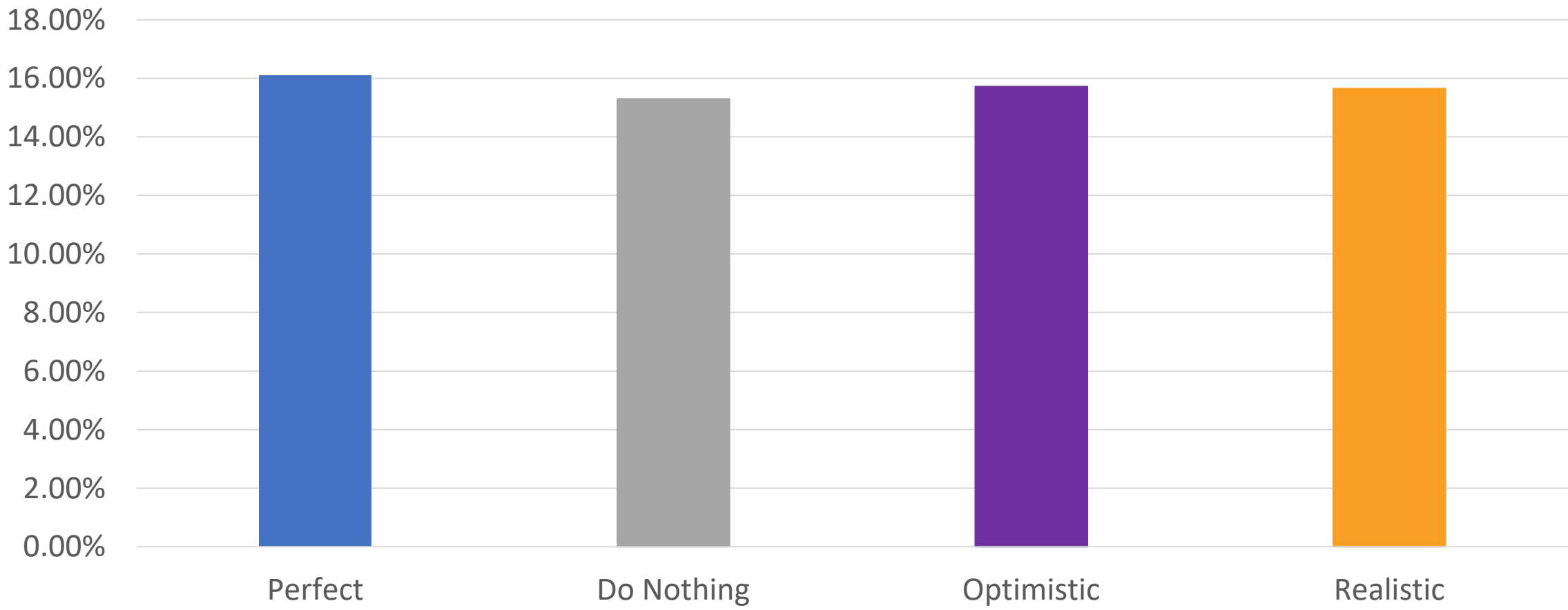
August 2023: Batteries missed the energy price peaks when peaks were outside typical hours.
Batteries **available during typical hours** still captured the peaks as they happened again in the day.



August 2023: Surely batteries will do better on the 3rd consecutive day. **No**

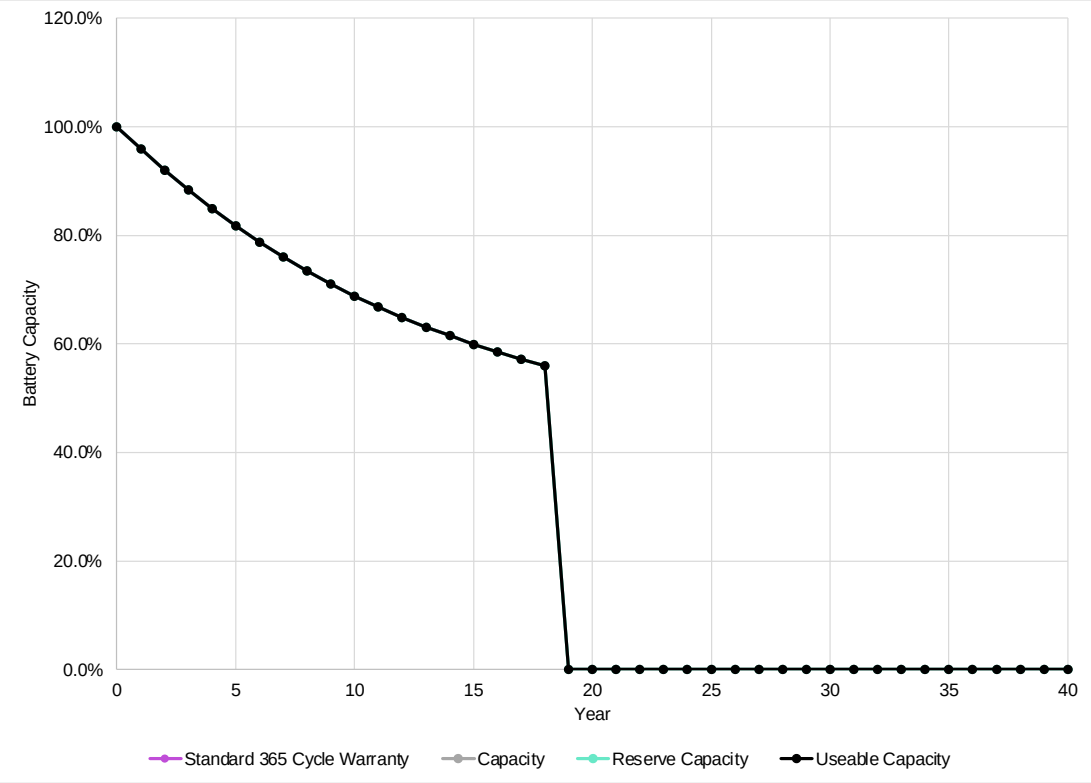


Bid Optimization (+0.3%)

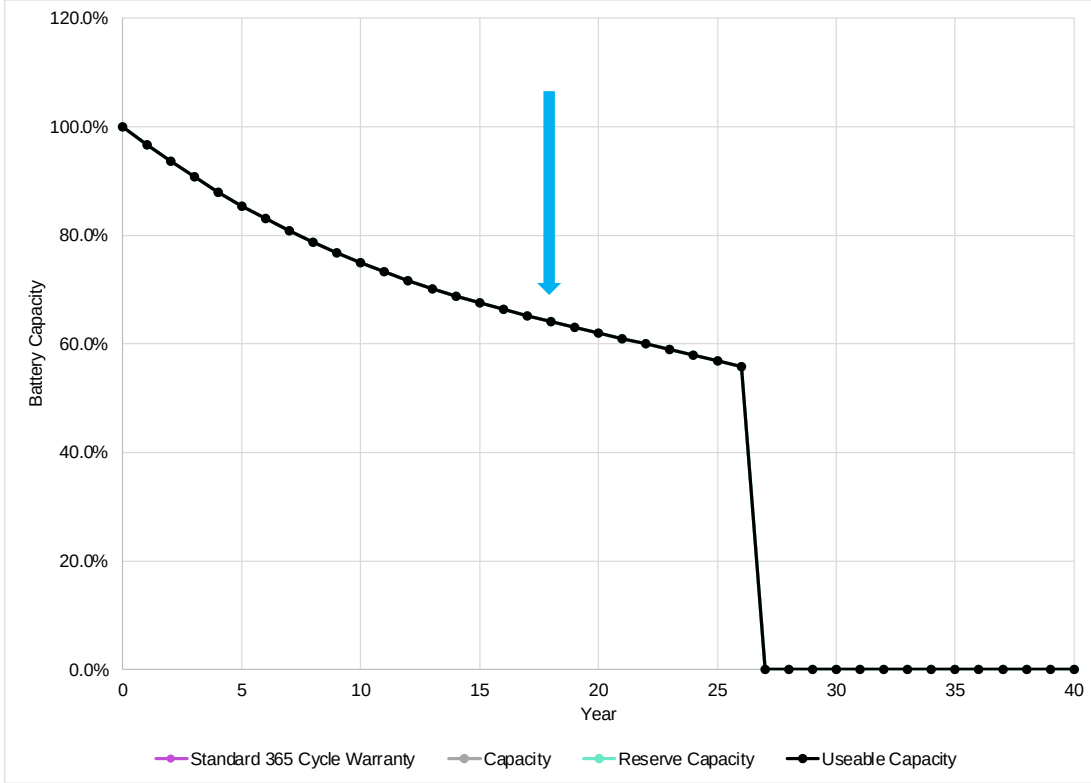


Perfect (unattainable): 25% more expensive inverters & thermal management → 99% Availability → 100% perfect, 0% fees → 16.1% IRR
Do nothing (no bid opt): 25% more expensive inverters & thermal management → 99% Availability → 95% perfect, 0% fees → 15.3% IRR
Optimistic (not realistic): 25% more expensive inverters & thermal management → 99% Availability → 99% perfect, 1% fees → 15.72% IRR
Fractal (realistic): 25% more expensive inverters & thermal management → 99% Availability → 98% perfect, 0.5% fees → **15.65%** IRR

Cheap inverters and thermal management → 95% Availability → 365 cycles per year → 99% perfect, 1% fee → 50% rSOC → 18 yr → 14.4% IRR



25% more expensive inverters and thermal management → 99% Availability → 300 cycles per year → 98% perfect, 0.5% fee → 25% rSOC → 26 yr → volatile node→ **18.3% IRR**



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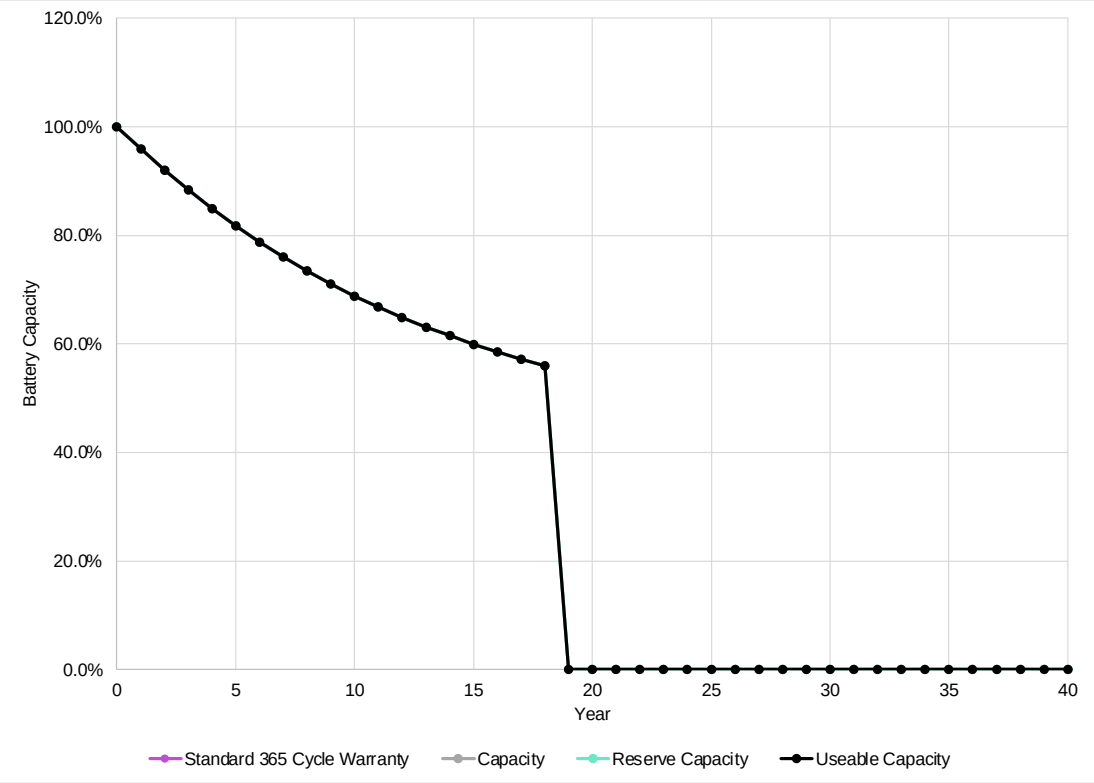

Traditional Integrator: 8.9%

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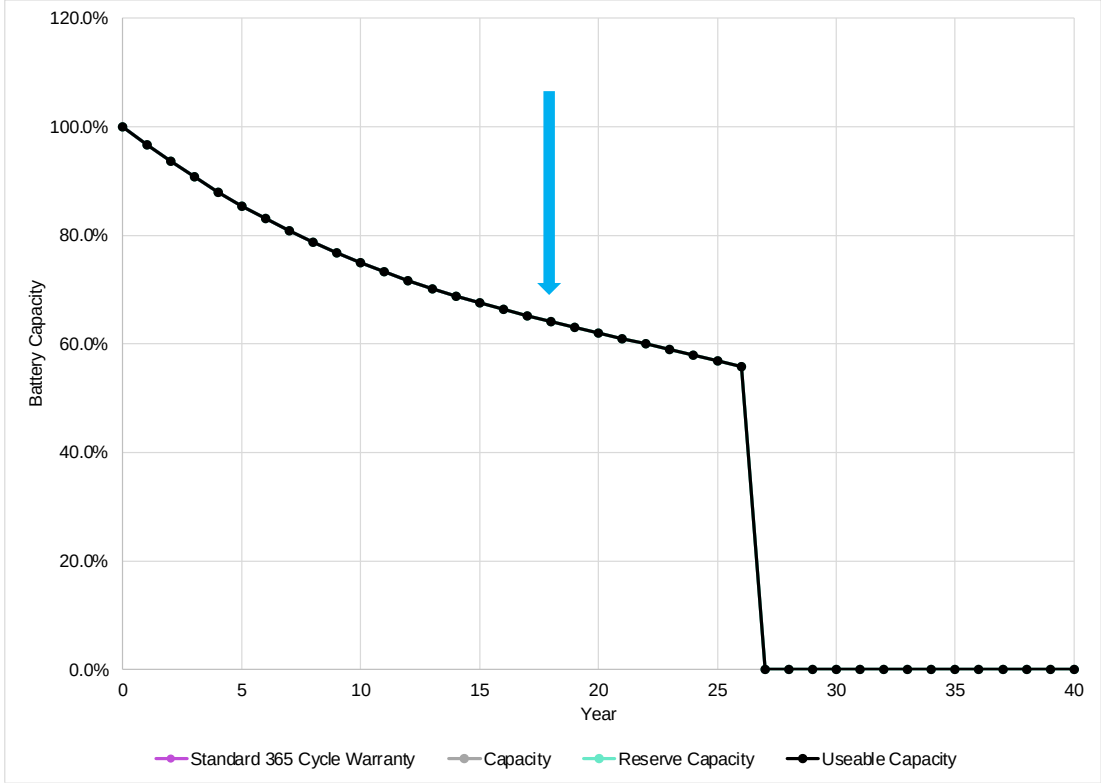

Traditional Integrator: 12.8%

FRACTAL EMS

Questions