

BREAKTHROUGH LOW-COST, MULTI-DAY ENERGY STORAGE

NorthWestern Energy ETAC
June 25, 2025

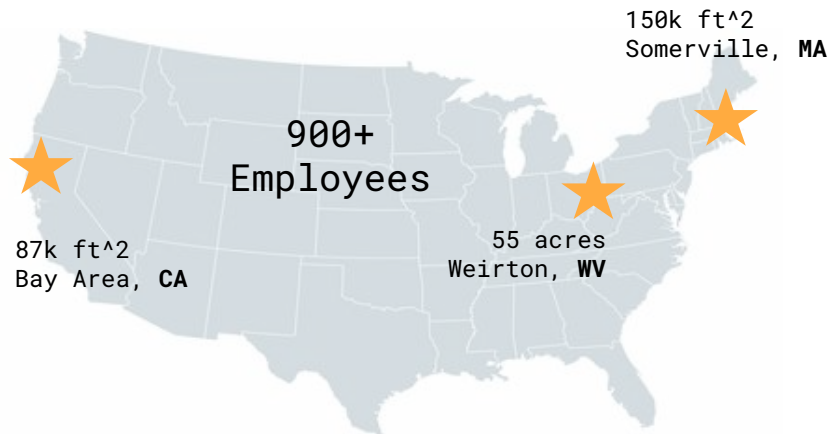


Energy Storage
For A Better World



Intro to Form Energy

Form Energy Overview



OUR INVESTORS: LONG-TERM AND IMPACT-FOCUSED

\$1.2B+ in venture capital from top investors including: T. Rowe Price, GE Vernova, Breakthrough Energy Ventures (BEV), TPG Rise Climate, Coatue, GIC, NGP, ArcelorMittal, Temasek, Energy Impact Partners, Prelude Ventures, MIT's The Engine Ventures, Capricorn's Technology Impact Fund, Eni Next, Macquarie Capital, Canada Pension Plan Investment Board, and other long-term, impact oriented investors

LED BY ENERGY STORAGE VETERANS

Decades of cumulative experience in energy storage

- 100's of MW of storage deployed

TESLA
ENERGY

A123
SYSTEMS

SUNPOWER
FROM MAXEON SOLAR TECHNOLOGIES

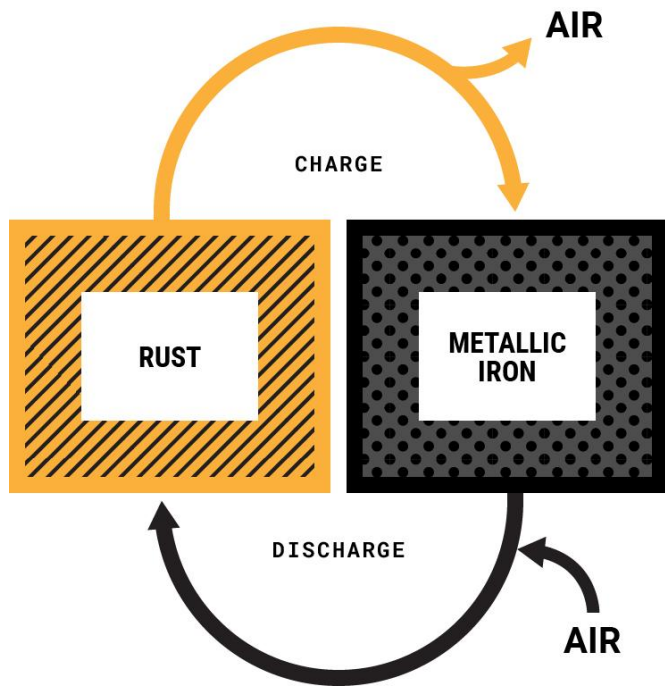
24M

NEXTERA
ENERGY



Rechargeable iron-air is the best technology for multi-day storage

Form's 100-Hour Reversible Rust Battery



COST

Lowest cost rechargeable battery chemistry.
Chemistry entitlement <\$1.00/kWh



SAFETY

No thermal runaway (unlike li-ion)
Non-flammable aqueous electrolyte



SCALE

Iron is the most globally abundant metal
Easily scalable to meet TW demand for storage



DURABILITY

Iron electrode durability proven through decades
of life and 1000's of cycles (Fe-Ni)

What makes up a Form Energy system

Modular design enables easy scaling to GWh systems

Cell



~0.15 kW / 15 kWh

~1.37m x 0.94m x 70mm

Electrodes + electrolyte

Smallest electrochemical functional unit

Battery Module



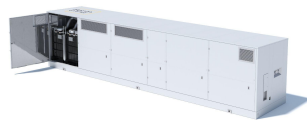
~4.5 kW / 450 kWh

~1.8m x 1m x 2.5m

30 cells

Smallest building block of DC power

Enclosure



~45 kW / 4,500 kWh

~9.5' x 8' x 40'

10 modules

Product building block with integrated auxiliary systems

Power Block



~2.9 MW / 290 MWh

<2 acres

64 enclosures

Smallest independent system and AC power building block

System



10+ MW / 1000+ MWh

5+ acres

Many power blocks

Commercial intent system



Battery module assembly

Deployed enclosure



Form Factory 1: U.S. Based Commercial-Scale Manufacturing

Transforming Weirton Steel Land for Battery Manufacturing in West Virginia

- **Production Capacity:** 500 MW / 50 GWh annually by 2028
- **Trial Production Start:** September 2024
- **Commercial Production Start:** 2025
- **Total Local Investment:** \$760 million by 2028
- **Jobs:** Minimum 750 full-time jobs by 2028
- **Location Benefits:** Local manufacturing know-how, strong natural infrastructure



Form Factory 1 site, June 2023



Form Factory 1, July 2024 (first ~500k sqft)

Form Factory 1 commercial battery production has started

Ramping to 50 GWh/yr manufacturing capacity by 2028 in Weirton, WV

Summer 2024: new 500,000+ sq.ft facility built



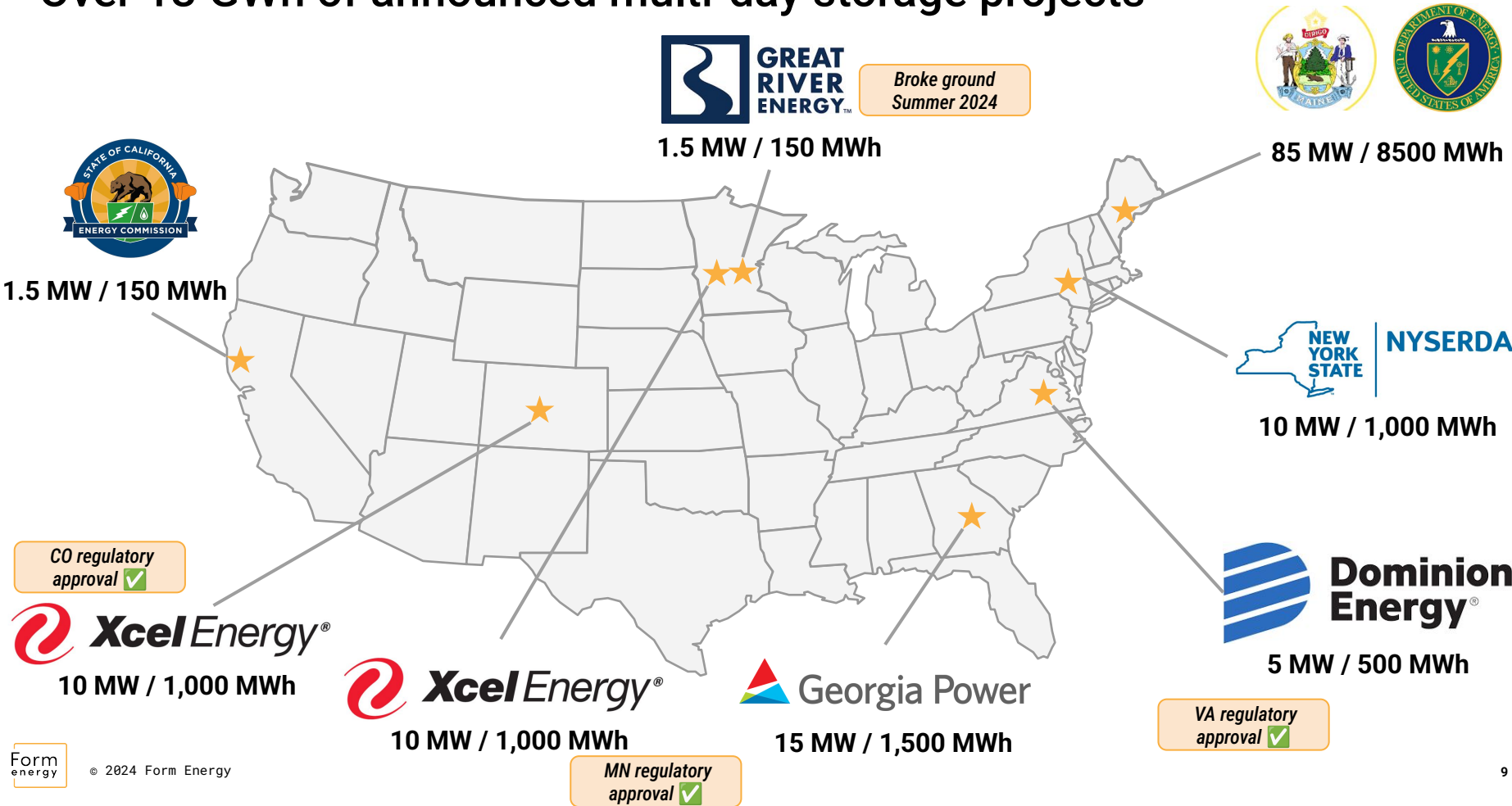
■ <18 months from breaking ground to battery production

Fall 2024: Battery Manufacturing Started

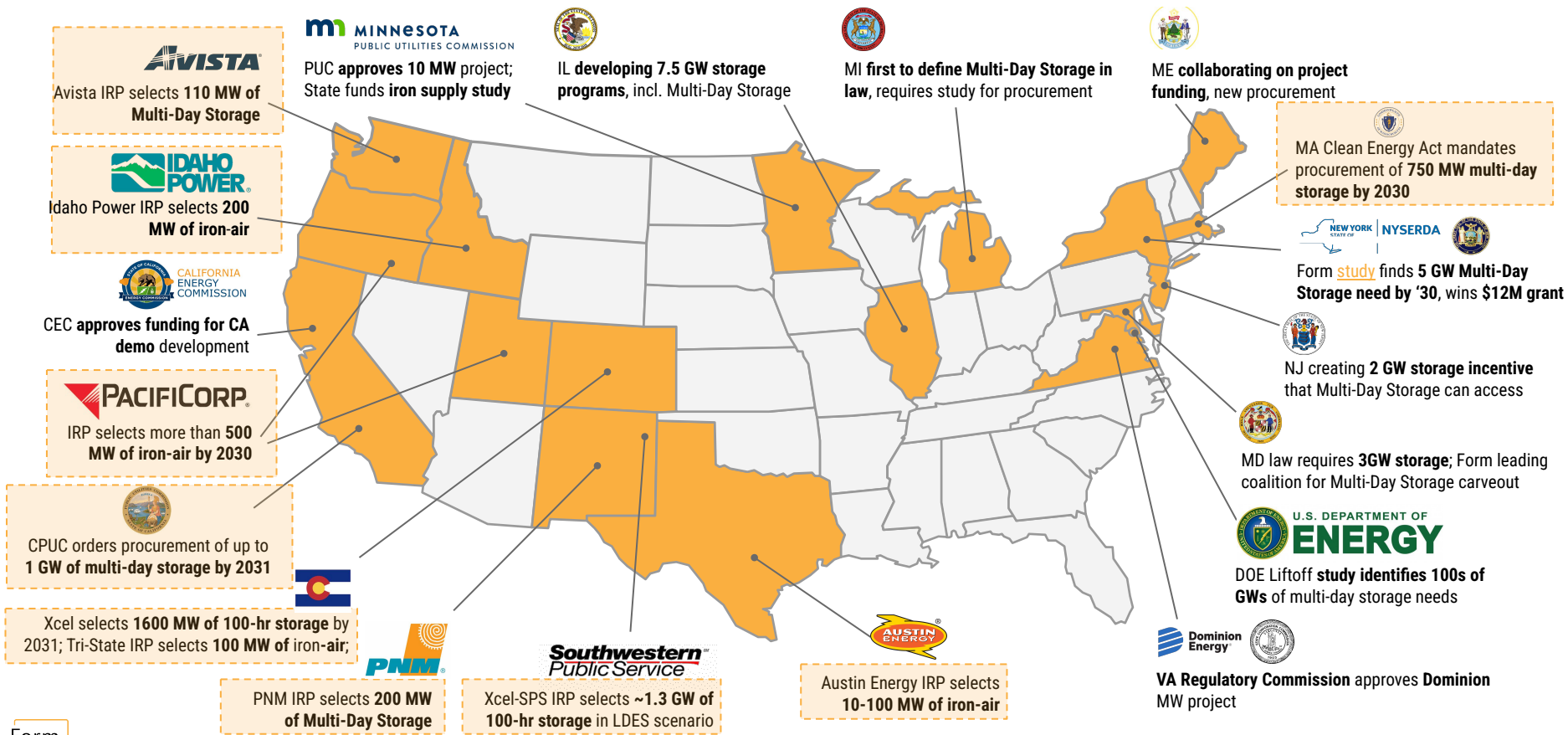


■ Semi-to-fully automated assembly for electrode, cell assembly, module assembly, and integrated enclosure

Over 13 GWh of announced multi-day storage projects



Utilities and state agencies are calling for gigawatts of Multi-Day Storage in their future resource plans⁽¹⁾



Notes: (1) For resource planning purposes, Multi-Day Storage defined as energy storage of at least 24 hours in duration. As of Q1 2024, Form has tracked 8 utilities that have modeled ~2.1 GW of Multi-Day Storage in their future resource plans. ERCOT = Electric Reliability Council of Texas, IRP = Integrated Resource Plan, LDES = Long Duration Energy Storage, PUC = Public

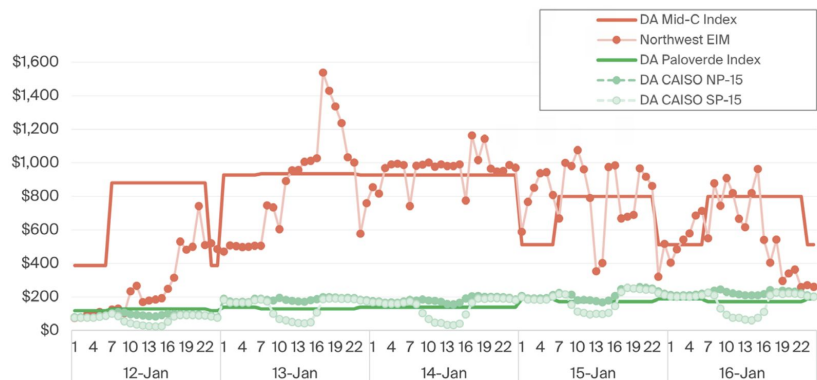
Multi-day Storage in NorthWestern's portfolio

The Northwest region is vulnerable to multi-day reliability risks driven by weather

Example: January 2024, MLK Weekend Winter Storm

Surge in wholesale market prices for 5 continuous days

Western US Wholesale Energy Prices

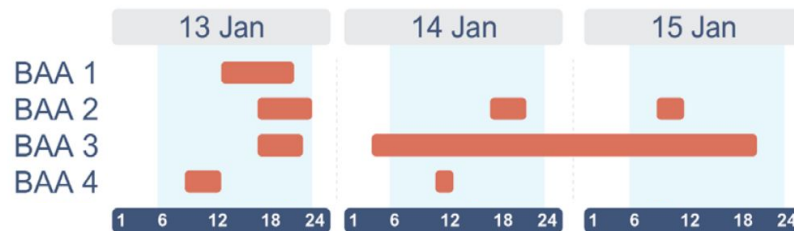


Northwest EIM reflects the average of the 15-minute EIM prices for Bonneville Power Administration, PacifiCorp West, Portland General Electric, Puget Sound Energy and Seattle City Light.

Source: ICE, CAISO OASIS

Emergency conditions declared for 48+ hours

Energy emergencies declared by 4 BA's in the Northwest



The Northwest is exposed to **reliability events which last for days at a time** – and are no longer limited to peak demand hours.

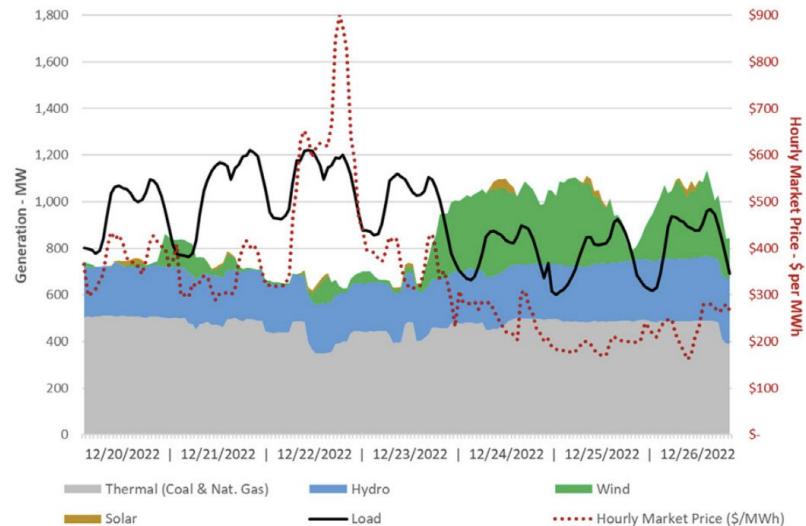
Note: Figures sourced from March 2024 report “Analysis of the January 2024 Winter Weather Event” by Powerex ([link](#))

NorthWestern Energy's 2023 IRP identifies a near-term need for long-duration resources in the face of tightening grid conditions

- 2023 IRP performs a “duration analysis” of grid stress periods over 5 years of historical data, which finds that:
 - High load events (top ~15%) can last for up to **45 hours**
 - Extreme load events (top ~1%) can last for up to **11 hours**
- Long-duration resources deliver dispatchable energy during such periods, insulating Northwestern from scarcity in regional market imports and gas supply
- Deployment of long-duration resources can bridge near-term capacity needs identified as early as 2028 in Northwestern Energy's IRP

Long-duration resources hedge **WECC market scarcity** and **gas supply risks** during extended grid stress events

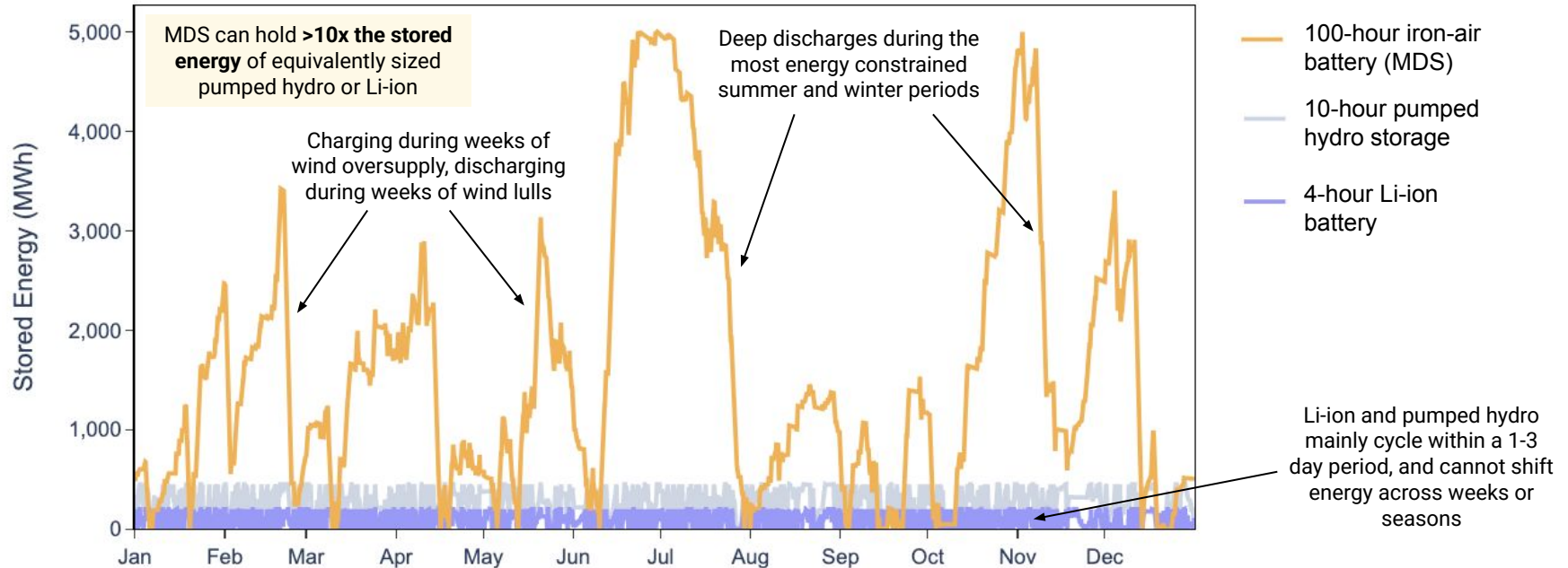
Figure 6-10. December 2022 Cold Weather Event – Load and Prices



Multi-day storage (MDS) is a low-cost energy reservoir – delivering firm capacity by shifting energy across days, months, and seasons

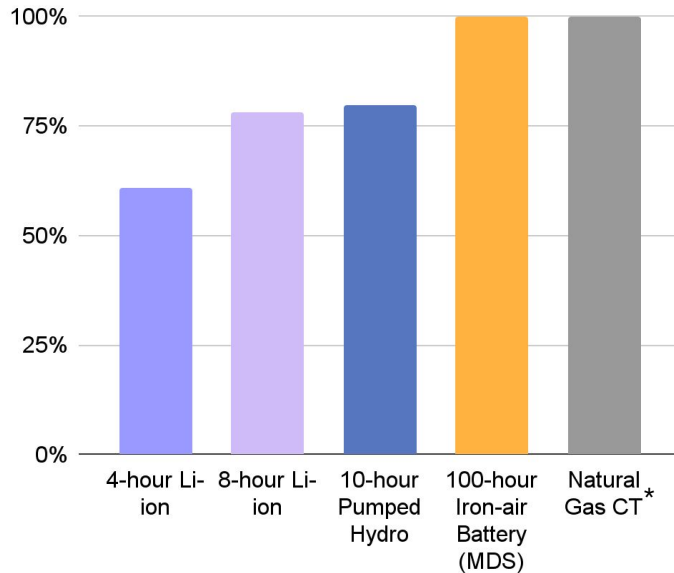
Simulated annual operations of storage on NorthWestern Energy system

Comparing stored energy in different 50 MW battery systems



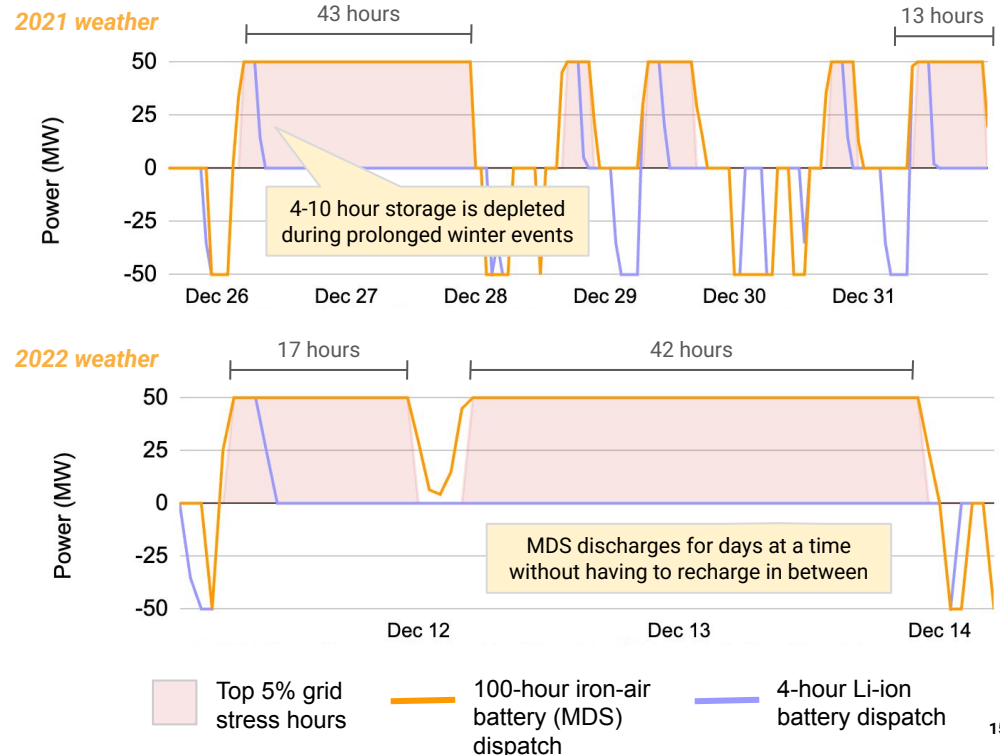
Multi-day storage (MDS) delivers firm capacity across 100% of high grid stress hours in a way that other resources cannot

Deliverability during NWE's top 5% grid stress hours



*Gas CT deliverability could be <100% during fuel shortages

Example operations during NWE's top 5% grid stress hours

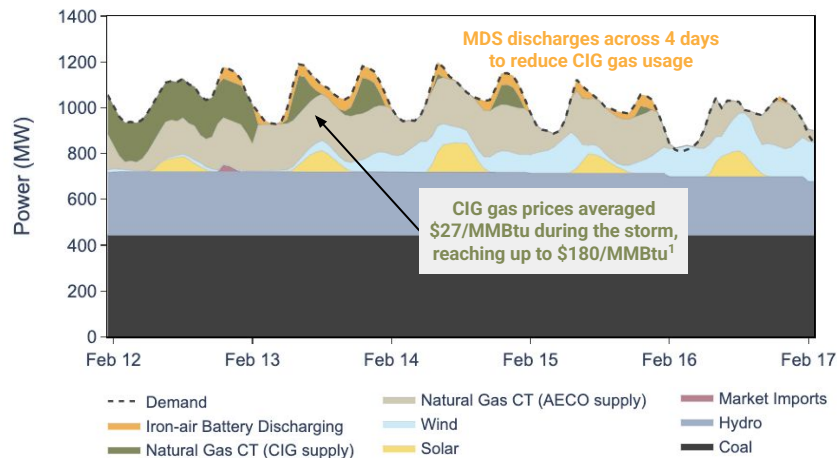


MDS protects NorthWestern from volatility in gas and power markets

MDS hedges against price shocks at CIG gas hub

Example: Price Shock during Winter Storm Uri

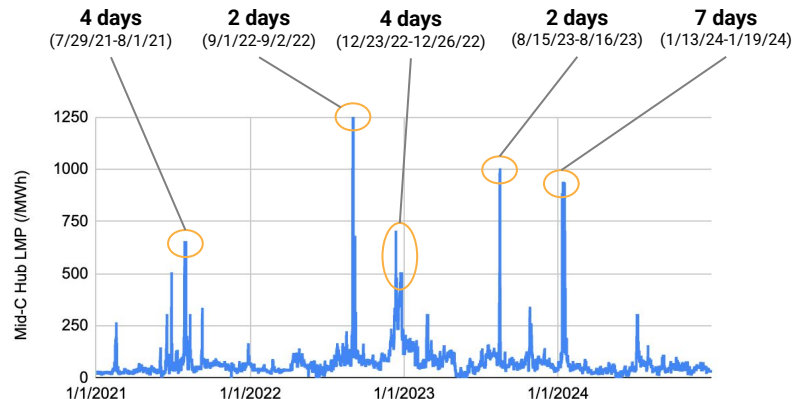
Simulated operations of current portfolio + 50 MW of MDS



During Winter Storm Uri conditions, a 50 MW MDS system **saves Northwestern \$0.5M in fuel costs**; ~5x the savings from a 50 MW 4 hour Li-ion system

MDS hedges against scarcity pricing at Mid-C power hub

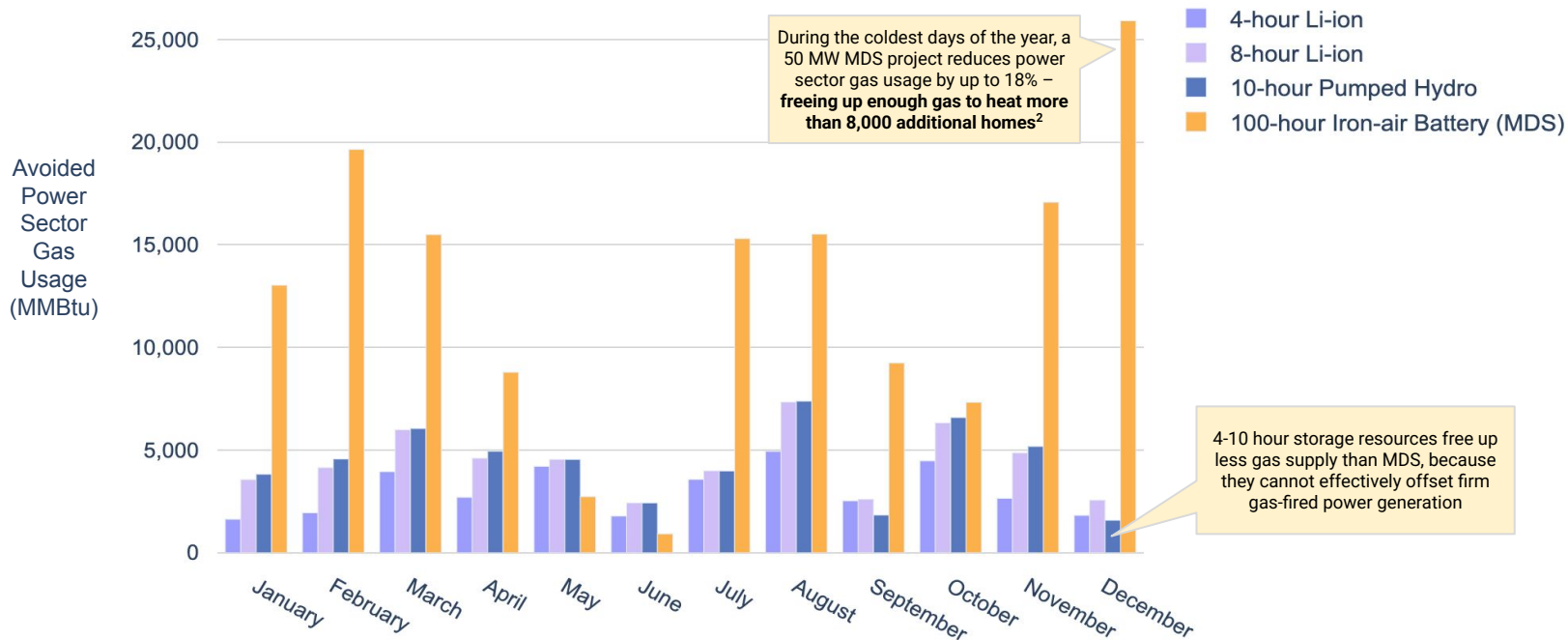
Mid-C Hub Scarcity Pricing Events, 2021-2024²



MDS can deliver stored energy for days at a time, **reducing reliance on WECC market imports during 2-7 day scarcity pricing events**

MDS enables NorthWestern to serve gas to more homes and businesses, by offsetting power sector gas consumption during periods of tight supply

Gas supplies made available during peak usage days (3-day max of each month)¹
from 50 MW storage projects on NorthWestern Energy's 2028 system



Of all options to meet NorthWestern's growing capacity needs, iron-air wins on reliability, cost, safety, and speed to deploy

	100-hour Iron-air Battery	4-hour Li-ion Battery	8-hour Li-ion Battery	10-hour Pumped Hydro Storage	Natural Gas CT
Deliverability during grid stress hours ¹	100%	61%	78%	80%	100%, subject to gas supply
Levelized Cost of Firm Capacity (\$/kW-yr) ²	\$280/kW-yr	\$460/kW-yr	\$560/kW-yr	\$380/kW-yr	\$200/kW-yr
Fire Risk	No	Yes	Yes	No	No
Expected Speed to Deploy	2 years	2 years	2 years	5-10 years	4-7 years

- (1) Ability of resources to deliver firm capacity during the top 5% of grid stress hours on Northwestern Energy's system, simulated using 2021-2022 historical weather conditions. Analysis presented on slide 15.
- (2) Measures the total annual cost of ownership for each resource per kW of firm, accredited capacity. Cost and capacity accreditation assumptions derived from 2023 NorthWestern Energy IRP and 2025 market data points from utility/ISO planning documents.

Key considerations for utilities in planning and procurement

Utilities should facilitate fair consideration of long-duration / multi-day energy storage resources

PLANNING

Include MDS / LDES resources as options in utility modeling; model them correctly

RELIABILITY

Consider extended time frames of grid stress events in Resource Adequacy constructs, and consider resource interactions; accredit MDS resources

PROGRAM DESIGN

Consider duration (energy) in addition to capacity in energy storage programs

DEPLOYMENT

Use technology-inclusive RFPs; ensure appropriate market signals for needed services

EDUCATION

Utilities gaining knowledge of, experience with, and influence over beneficial new technologies

IRP modeling approaches must capture grid volatility and weather-driven risks

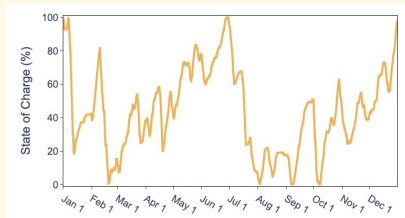
How does this benefit grid customers?

Select least-cost resource mix which can serve customers across every single hour of the year

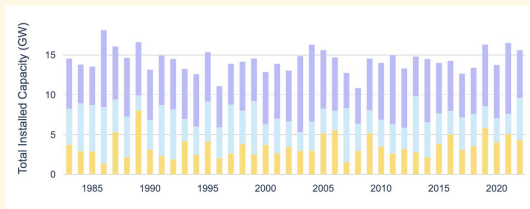
Ensures system is designed to manage critical reliability risks from high-impact weather events

Best practices for capturing grid volatility

- 1 Model **8760 hour grid operations** in capacity expansion and production cost simulation



- 2 Simulate a **diverse set of weather scenarios**, including atypical grid stress events

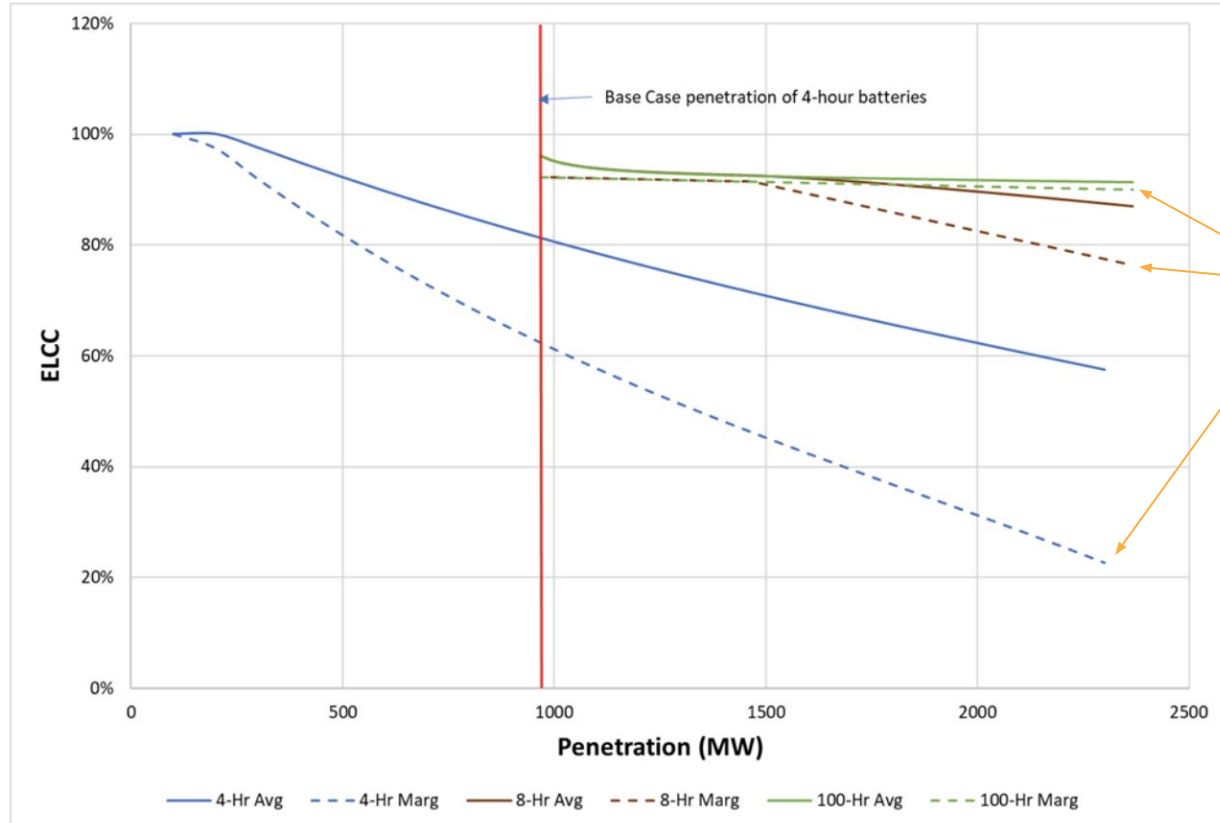


How does this better represent MDS?

Simulates monthly and seasonal arbitrage behavior, which is essential to multi-day storage operations

Surfaces the value of multi-day reliability assets during rare but predictable extreme weather events

IRP modeling should recognize the capacity accreditation benefits of multi-day storage relative to shorter duration resources

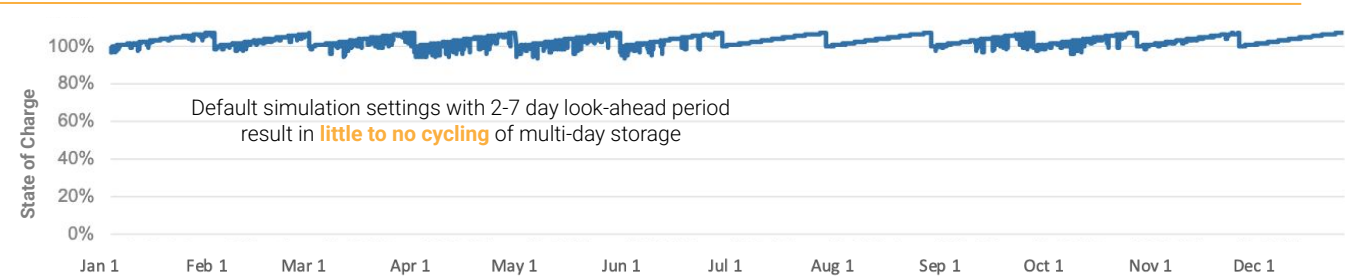


Storage technologies with longer durations will keep a higher capacity accreditation, even while their penetrations increase

IRP tools must be configured to accurately simulate multi-day storage

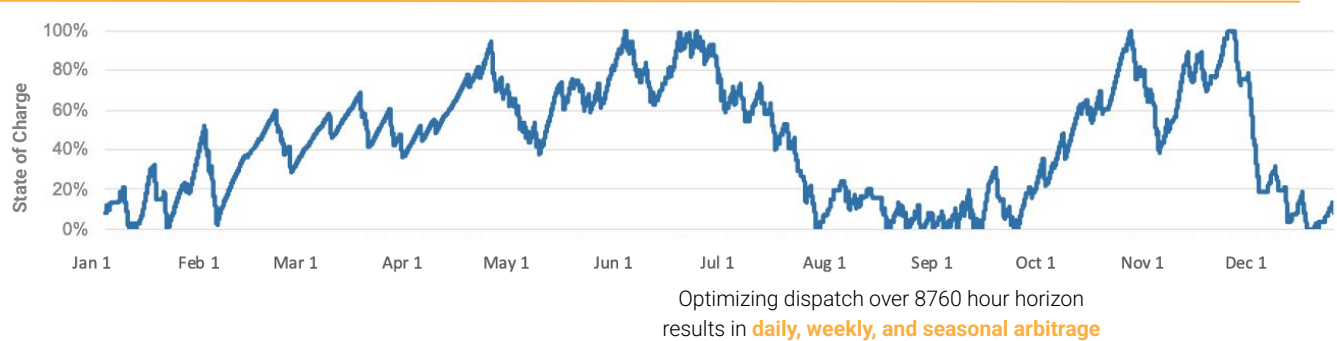
Simulated operations of 100-hour storage asset

Aurora (default simulation settings)



Conventional simulation methods can **grossly understate the value** of multi-day storage

Formware (optimized simulation settings)



RFPs should be designed to recognize high-value deployments of long-duration / multi-day storage



Include fit-for-purpose bankability requirements that allow providers to demonstrate commercial track record, corporate, and technology backing.



Consider all technology benefits, such as reliability, resiliency, and land use savings across realistic weather conditions, rather than simplified heuristics like LCOC or LCOS alone



Ensure technology specifications focus on the necessary service, rather than a specific technology.



Use valuation frameworks which holistically assess system-wide benefits of projects.

RFP valuation frameworks should capture the full spectrum of system-wide cost and benefits from deployment of MDS/LDES

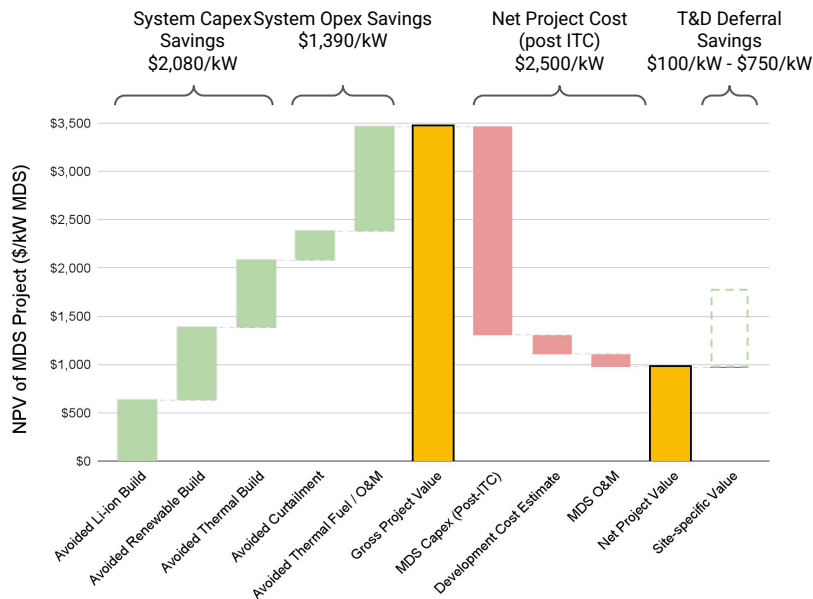


Holistic assessment of system-wide value



Incomplete metrics which neglect system-wide value

Avoided revenue requirement from 10 MW
MDS project on PNW utility system



LCOS comparison between MDS and
short-duration storage projects

Proposed Project	4 Hour Li-ion (10 MW)	Iron-air Battery (10 MW)
Capex	\$1200/kW	\$2000/kW
Opex	\$20/kW-yr	\$20/kW-yr
Expected Annual Discharge	13,000 MWh (15% capacity factor)	13,000 MWh (15% capacity factor)
Levelized Cost of Storage	\$80/MWh	\$140/MWh

Not an apples-to-apples comparison:

What matters is not just how much energy is delivered, but *when* it is delivered. MDS delivers more energy during critical reliability periods, which means it can offset more resource build on the grid.

Thank you!

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Appendix

Assessing the value of MDS via Formware modeling of NWE system

Key Data Inputs

- Most system assumptions aligned with NWE 2023 IRP:
 - *Candidate resource types and costs*
 - *Existing and planned resource attributes*
 - *Thermal retirement schedule*
 - *Historical CIG/AECO gas prices, Mid-C power prices*
- Hourly load and renewable profiles for two weather years (2021-2022):
 - *Load and renewable profiles rely on hourly solar, wind, and temperature data from NASA MERRA Reanalysis dataset*
 - *Load profiles calibrated to match NWE IRP load forecast (peak and annual energy)*
- Applied Form Energy's near-term and long-term cost projections for Iron-air battery

Modeling Framework

- Modeled of NWE's 2028 planned portfolio in Formware¹
- Simulated portfolio dispatch against 2 weather year scenarios (2021 and 2022)
- Determined high grid stress hours (top 5% marginal price hours)
- Assessed ability of different capacity resources to deliver energy during these periods
- Also ran dispatch simulations of Northwestern's current portfolio with the addition of 50 MW capacity projects of different types (Li-ion, pumped hydro, etc.)

¹Capacity expansion and production cost model developed by Form Energy to represent the dynamics of multi-day storage and weather variability with high fidelity