Valuing Distributed Batteries

Benefits of an Emerging Deployment Model

PREPARED BY

Ryan Hledik
Akhilesh Ramakrishnan
Cristina Crespo Montañés
Emine Taha

PREPARED FOR

Base Power

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Brattle



Purpose of the study

The study has two objectives:

1 **Estimate the value of residential-sited batteries relative to utility-scale batteries for an example utility system.**

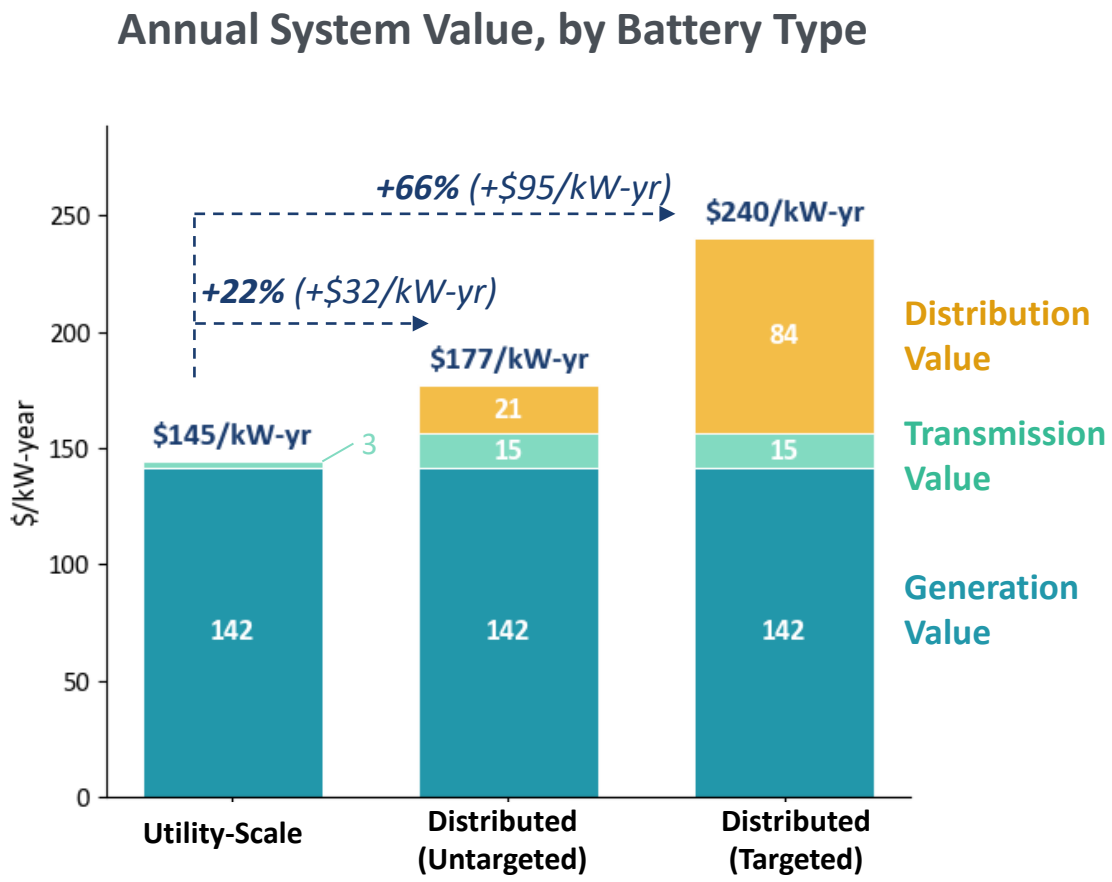
2 **Describe a repeatable methodology for estimating the value of distributed batteries that can inform utility planning and procurement.**

ANALYSIS SCOPE

We analyze a distributed battery portfolio with the following features:

- **Siting:** FTM at residential premises
- **Operation:** 4-hour discharge duration and dispatched to maximize bulk-system value while also providing T&D benefits
- **Control:** Utilities have direct, real-time control and telemetry
- **Deployment:** A “targeted case” in which batteries are deployed to areas with distribution capacity constraints, and an “untargeted” case in which that is not a consideration

Distributed batteries provide up to 66% greater value than utility scale batteries due to value stacking



Note: Values in 2024 dollars.

Scope Overview

GEOGRAPHY & SCALE

We use MISO data and an illustrative Midwestern utility. We illustrate how value would scale to the utility level. These data do not fully characterize the conditions on a particular distribution system.

VALUE

Generation, transmission, and distribution. We focus on use of MCOS to quantify Dx value for batteries. We present battery value per kilowatt of storage nameplate capacity on an annualized basis (i.e., $/kW-yr).

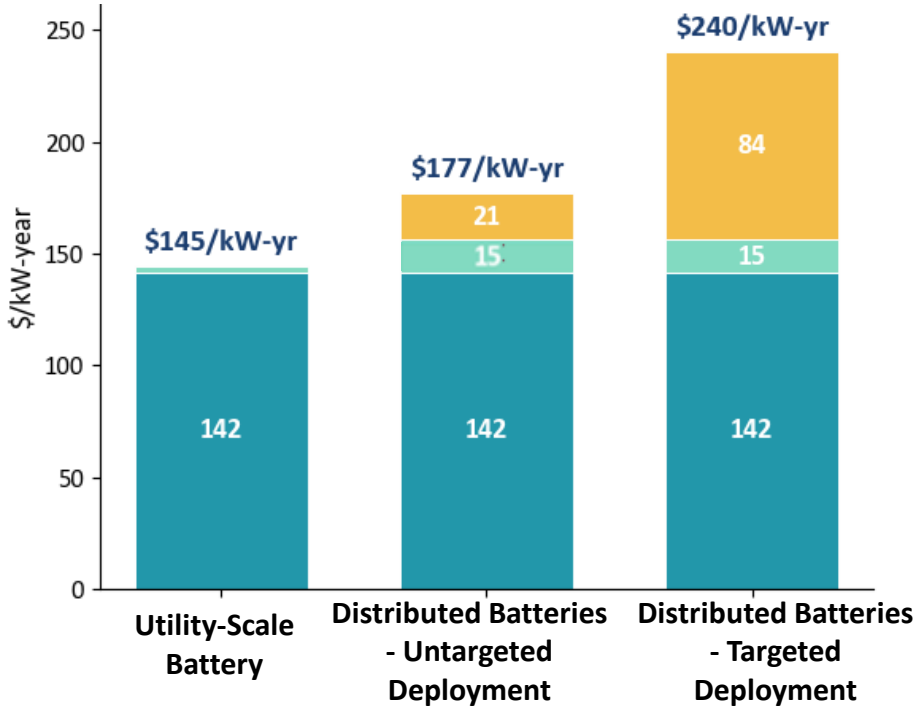
STUDY HORIZON

We use historical and forecasted market price, transmission system, and distribution system cost data for the period between 2024 and 2039.

SENSITIVITY ANALYSIS

We test the sensitivity of the incremental value of distributed batteries results to a broad range of distribution system conditions.

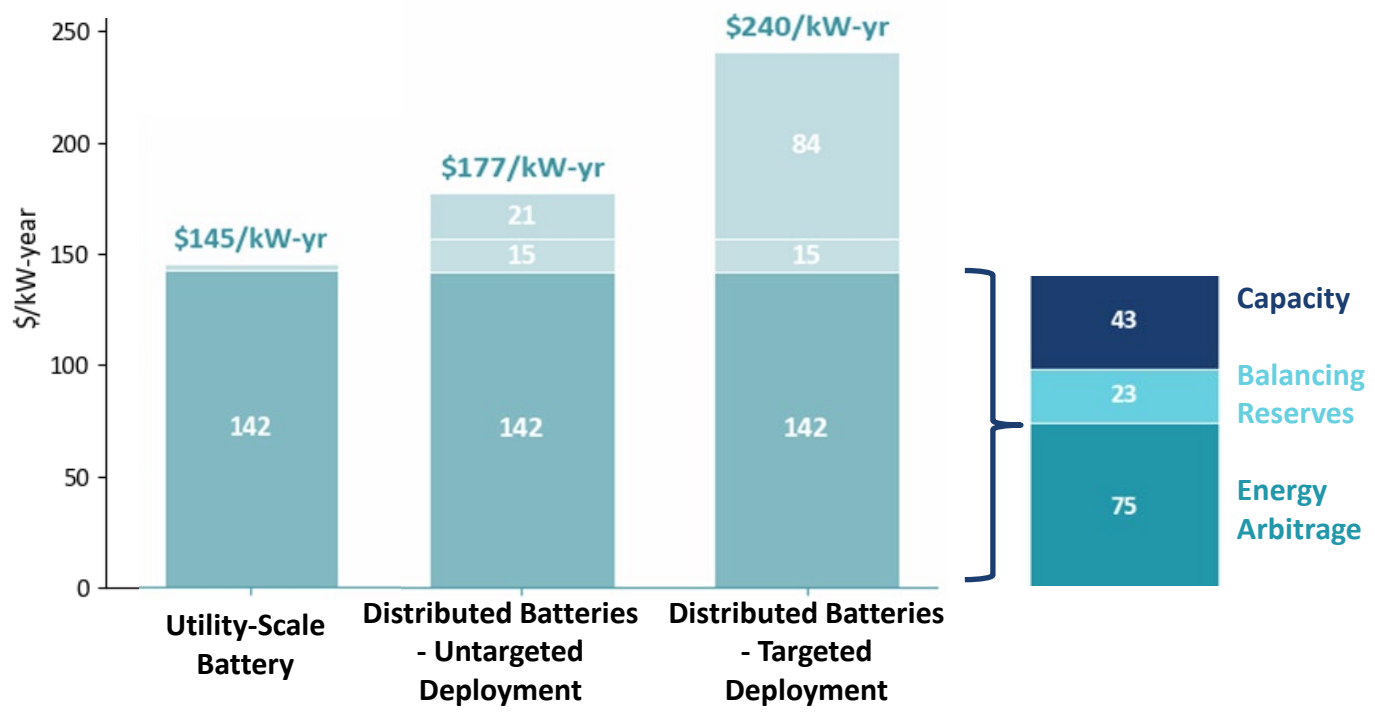
Quantified sources of battery value in our study



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GENERATION

We model capacity, energy arbitrage, and spinning-reserve value using MISO data and co-optimized battery dispatch. Generation value is constant across cases, though it may be higher in export-constrained areas with surplus renewable generation.



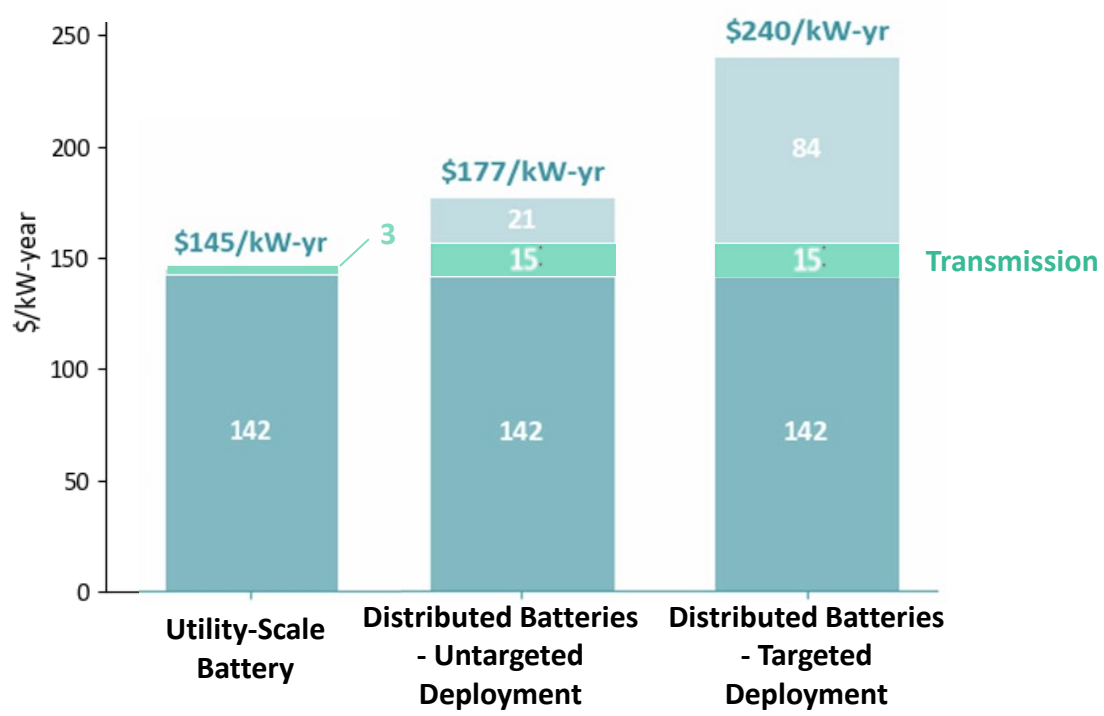
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TRANSMISSION

We estimate the cost of load-growth-driven expansion in MISO, and adjust for where batteries are sited. A battery still must relieve the relevant constraint to defer a particular project; transmission investments driven by other needs may call for different solutions.



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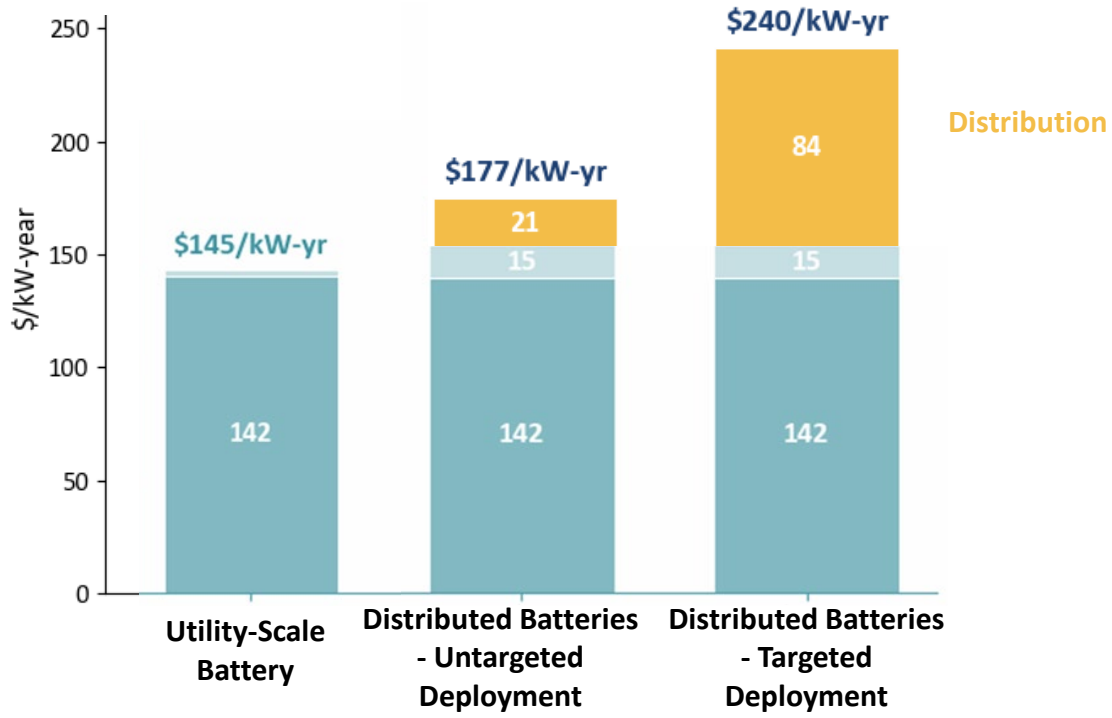
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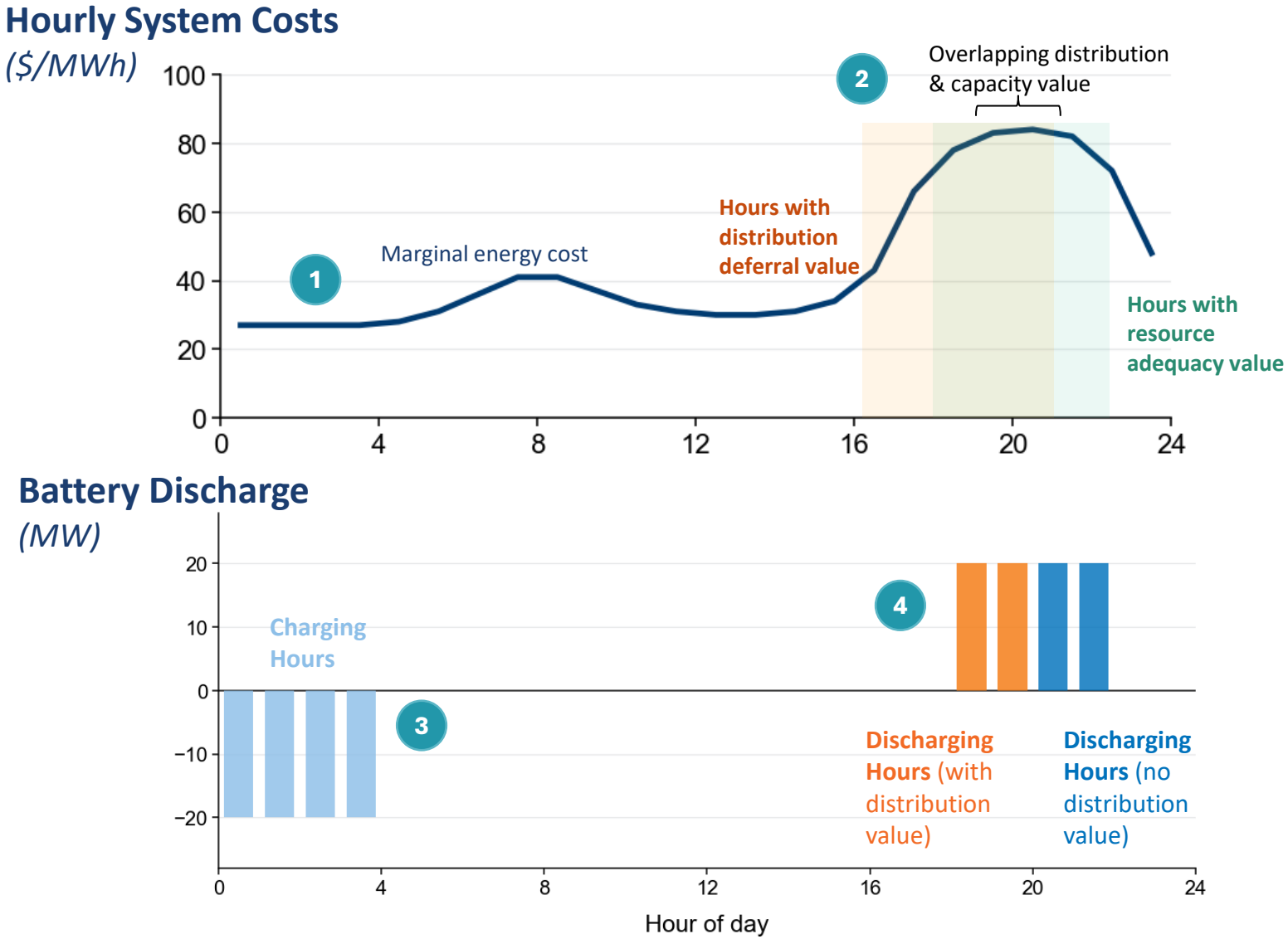
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DISTRIBUTION

We estimate the local marginal cost of serving load growth and credit battery output that coincides with the Dx capacity need.
Next sections explain this MCOS and battery contribution framework in more detail.



How the distributed batteries provide value: An illustration



1. **Off-peak hours:** Energy costs are low, no resource adequacy or distribution capacity need.

2. **Evening peak:** Energy costs and resource adequacy needs rise, while local distribution constraints may occur in some hours.

3. **Battery charging:** costs are low and the system is unconstrained.

4. **Battery discharging:** prioritizes energy and resource adequacy value. Discharge overlapping local distribution peaks also creates headroom.

Framework overview

Distribution value depends on the cost of a local grid need, the battery's contribution to meeting it, and where the portfolio is deployed.

BATTERY PORTFOLIO DISTRIBUTION VALUE = **MCOS in battery-sited locations** × **DLCC of the battery portfolio in battery-sited locations**

1

Marginal Cost of Service (MCOS) Study: Locate and price grid needs

Forecast constraints and calculate the annual cost of serving additional load at each location. MCOS is zero where existing capacity is sufficient.

2

Distribution Load Carrying Capability (DLCC) Study: Accredit DER capacity

Estimate how much battery operation reduces the local capacity need, accounting for the timing, duration, and size of discharge.

3

DER Value: Apply MCOS and DLCC based on DER siting and operations

Credit batteries at locations where they can meet the need, and cap the portfolio's value at the expected capacity requirement.

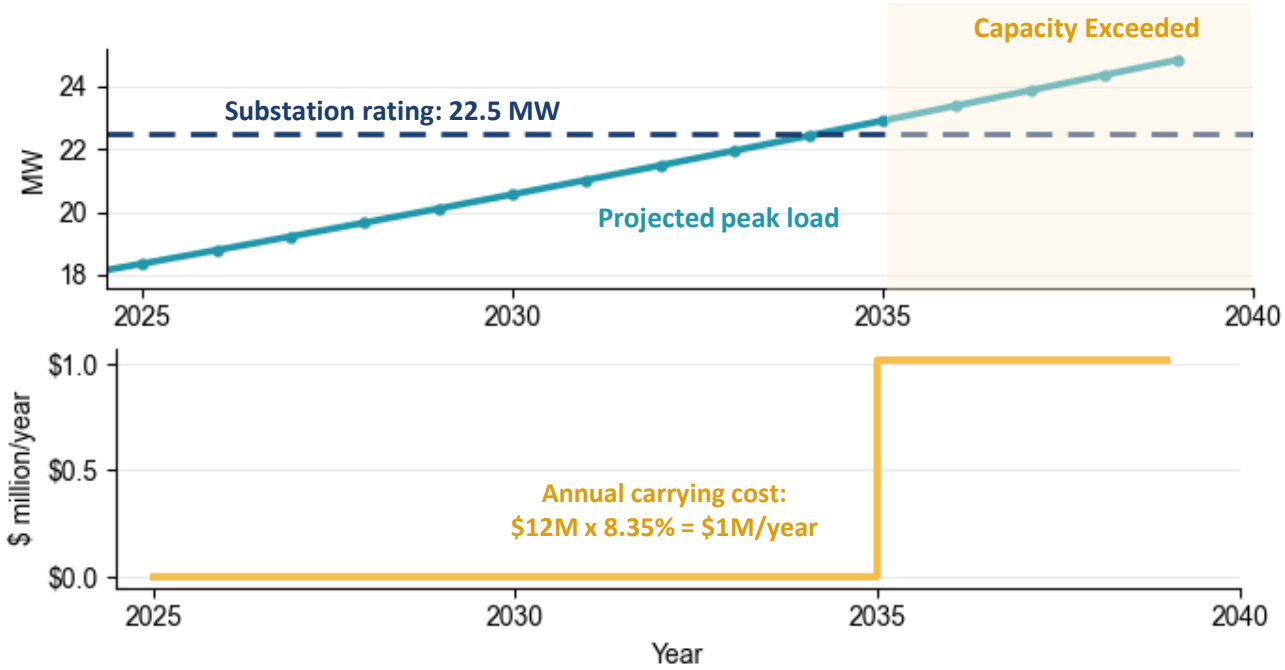
This framework can be broadly applicable to various types of DER deployment models.

FRAMEWORK FOR ESTIMATING DISTRIBUTION VALUE

Illustrative MCOS calculation for a constrained substation

Based on the projected load growth and the cost of addressing the constraint, the MCOS in this example location is $84/kW-year:

1. **Forecast the capacity need**
2. **Estimate and annualize the upgrade cost**
3. **Levelize cost over load growth**



$$\text{MCOS } (\$/kW\text{-yr}) = \frac{\text{PV of annualized incremental distribution cost to serve forecasted load growth}}{\text{PV of cumulative annual forecasted load growth}} = \frac{\$\ 3.2\ M}{38\ MW\text{-year}} = \$\ 84/kW\text{-yr}$$

The levelized distribution capacity cost associated with incremental load growth at this location is $84/kW-year over the study period.

Defining distribution load carrying capability

A location- and resource-specific DLCC should be developed to account for the extent to which a DER can reliably reduce loading on a specific distribution asset given the expected operating characteristics of the DER.

1 Forecasted asset load profile

The load shape of the distribution asset will determine the timing of load reductions needs.

2 Target load reduction

Set a meaningful level of target load reduction based on the forecasted rate of load growth and limit exceedance at the asset. The illustration shows a 5% reduction. This identifies the timing and duration of load reductions needed for meaningful distribution value in this location.

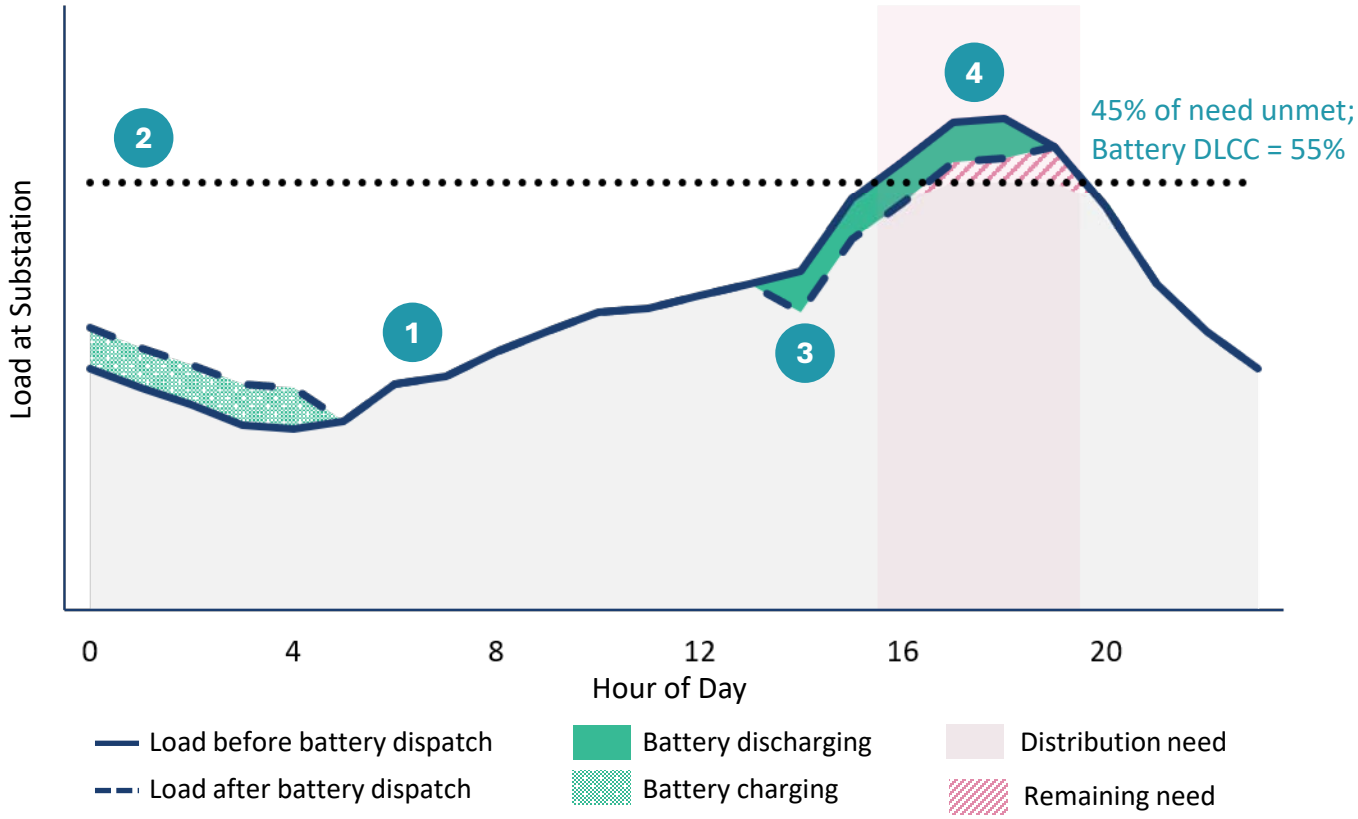
3 Expected DER operating profile

The magnitude, duration, frequency, and timing of load reductions that the DER is expected to provide. In this study, the battery's operation is modeled based on the hours of high energy prices, with no consideration of distribution grid needs.

4 Load carrying contribution

The fraction of the DER's output that is likely to contribute to meeting the distribution grid need. Where data is available, this analysis can be conducted probabilistically, with consideration of different possible load shapes and DER operating profiles.

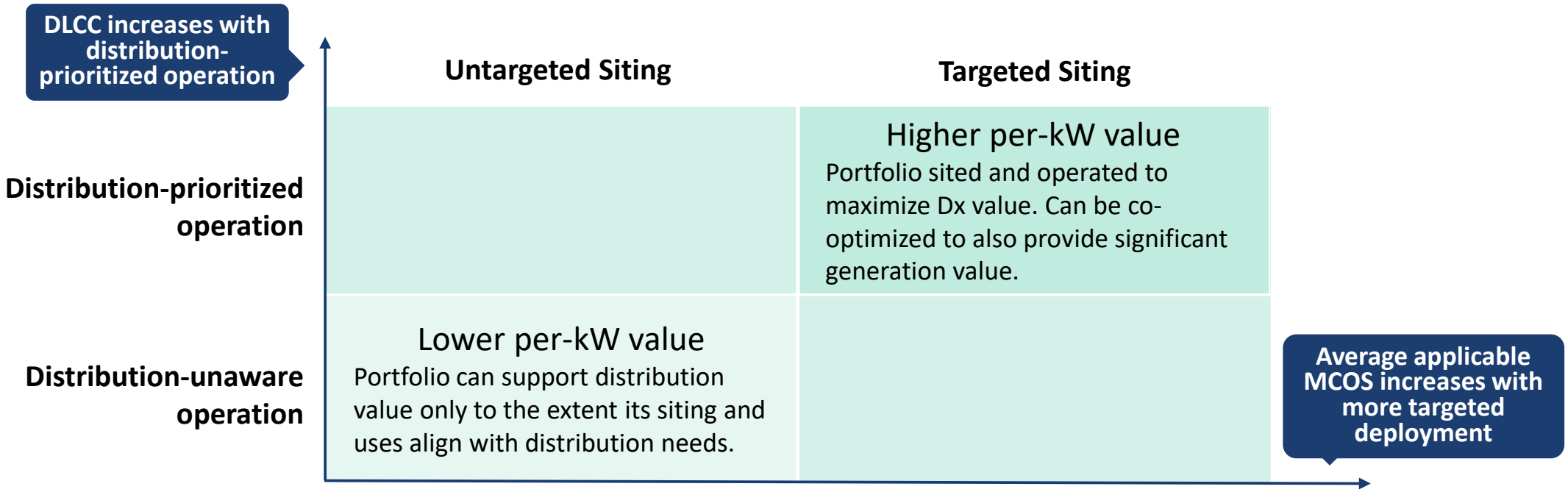
Illustrative DLCC Analysis for Batteries at a Substation



Potential siting strategies and operating modes

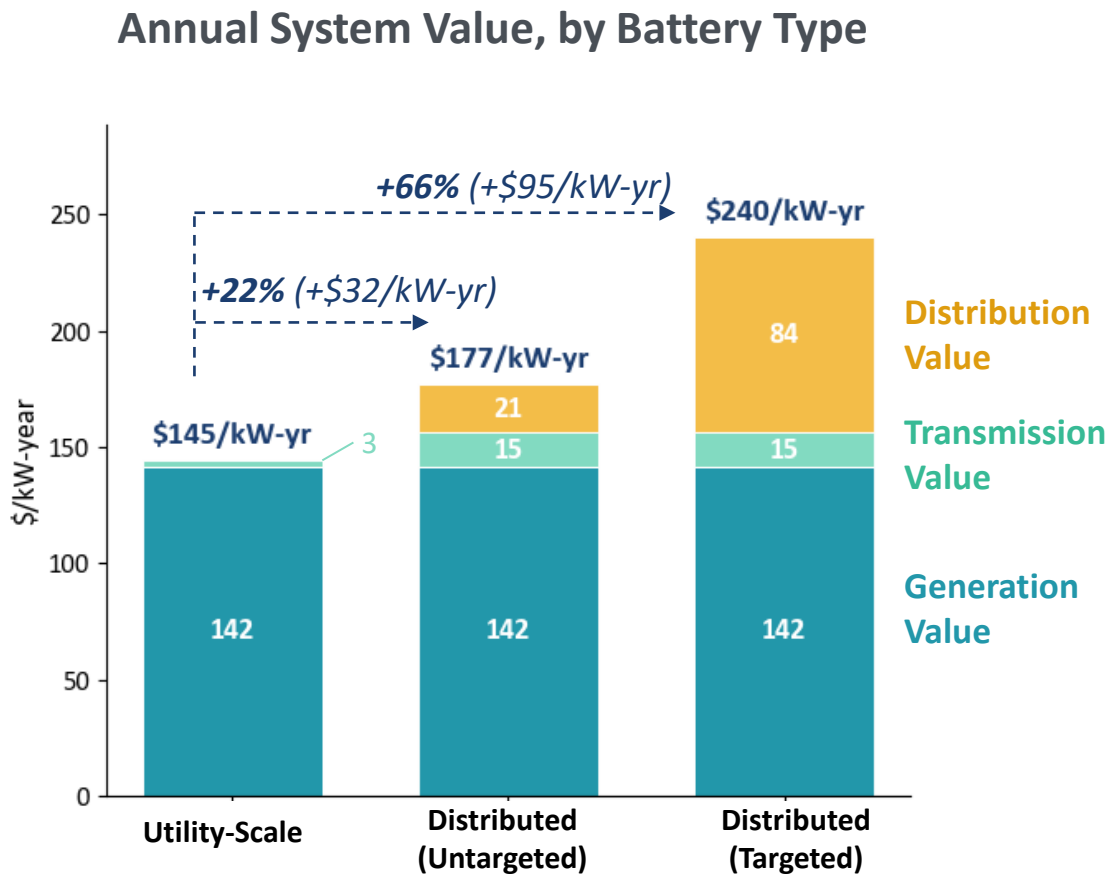
Siting strategy and operational priority determine distribution value of distributed battery portfolios

BATTERY PORTFOLIO DISTRIBUTION VALUE = **MCOS in battery-sited locations** × **DLCC of the battery portfolio in battery-sited locations**



The added value of distributed batteries

By being located at the grid edge, distributed batteries can provide transmission and distribution investment deferral value that is incremental to the generation value provided by utility-scale batteries.



Note: Values in 2024 dollars.

Distributed batteries can provide significant benefits at scale

Scaling the estimates to a representative utility with 2 million residential customers indicates incremental value of up to $65 million

	Planning-based market potential scenario *200 MW*	Long-run technical potential scenario *1,000 MW*
Non-targeted Deployment *p.a. savings relative to utility-scale*	**$5M**	**$23M**
Targeted Deployment *p.a. savings relative to utility-scale*	**$17M**	**$65M**

Context: Net savings could offset up to 30% of a utility's revenue requirement of $200 million, if the batteries could be developed and deployed at the same cost as utility-scale batteries.

Several barriers need to be addressed to achieve the value identified in this study

	KEY BARRIER	POTENTIAL SOLUTION
1	**IRP models undervalue distributed storage** Often omitted, treated as demand response, or modeled with generic inputs that exclude avoided T&D.	**Model it as a dispatchable candidate resource** Use commercial cost/performance data (e.g., RFP bids) and capture capacity, energy, ancillary services, and avoided T&D.
2	**RFP eligibility excludes distributed fleets** Artificial requirements such as minimum-MW thresholds can make portfolios ineligible.	**Adapt procurement rules** Allow distributed resources to qualify as aggregated portfolios, with minimum size and site control requirements tailored to those portfolios.
3	**Evaluation methods miss the full value stack** Analysis may understate capacity accreditation, dispatchability, locational value, or distinct stacked services.	**Credit measurable system and locational benefits** Recognize RA/capacity and avoided T&D value and allow transparent value stacking across distinct services.
4	**VPP and tariff design constrain participation** Valuable features such as third-party ownership and exports to the grid may be prohibited.	**Use open, performance-based VPP structures** Enable aggregators and standalone assets, net export, dispatch incentives, and multi-year contracts.
5	**Cost assumptions may lag market conditions** Rapidly evolving distributed battery costs and business models may not be reflected in planning assumptions.	**Regularly update and benchmark resource costs** Use current market evidence and consistent cost definitions to compare distributed batteries with alternative resource options.

For further information



Ryan Hledik

PRINCIPAL | SAN FRANCISCO

Ryan.Hledik@brattle.com

Ryan focuses his consulting practice on regulatory, planning, and strategy matters related to emerging energy technologies and policies. His work on the grid edge has been cited in federal and state regulatory decisions, as well as by *Forbes*, *National Geographic*, *The New York Times*, *NPR*, and *The Washington Post*. He has published more than 30 articles on electricity matters, presented at industry events in 11 countries, given lectures on distributed grid economics at Penn, Stanford, and Yale, and served on the advisory boards of a demand flexibility startup and an energy storage trade association. Ryan received his M.S. in Management Science and Engineering from Stanford University, and his B.S. in Applied Science from the University of Pennsylvania.



Akhilesh Ramakrishnan

MANAGING ENERGY ASSOCIATE | TORONTO

Akhilesh.Ramakrishnan@brattle.com

Akhilesh specializes in integrated electric system planning, with a focus on economic, technical, and policy considerations related to distributed energy resource integration and load growth. He has a decade of experience advising utilities, regulators, renewable energy developers, and technology companies on a range of grid planning, modernization, and electrification challenges. Prior to joining The Brattle Group, he developed business strategy and policy for Exelon's electric and gas utility businesses. Akhilesh received his M.S. in Mechanical Engineering from Columbia University, and his B.Tech. in Electrical Engineering from SRM University, India.



Cris Crespo Montañés

ENERGY ASSOCIATE | SAN FRANCISCO

Cris.Crespo.Montanes@brattle.com

Dr. Crespo Montañés specializes in residential electrification, hybrid renewable-storage systems, and equitable energy transitions. She advises system operators and utilities on electrification strategy, distributed energy resource integration, and long-term resource planning. Previously, Cris was a researcher at Lawrence Berkeley National Laboratory, where she developed optimization models for hybrid renewable-plus-storage systems and coauthored studies on storage market valuation, residential distributed resource adoption in the US, and residential electrification.


BASE

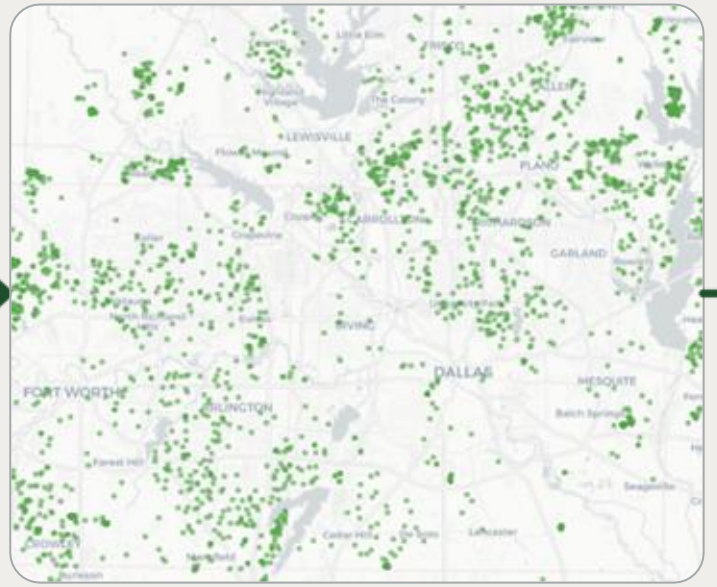
Base Power builds scalable distributed capacity for utilities



01

We design and manufacture purpose-built hardware

Our proprietary residential battery system (20 kW / 40 kWh)



02

We deploy it efficiently at thousands of homes

Adding 30 MW per month in just the Dallas metro area



03

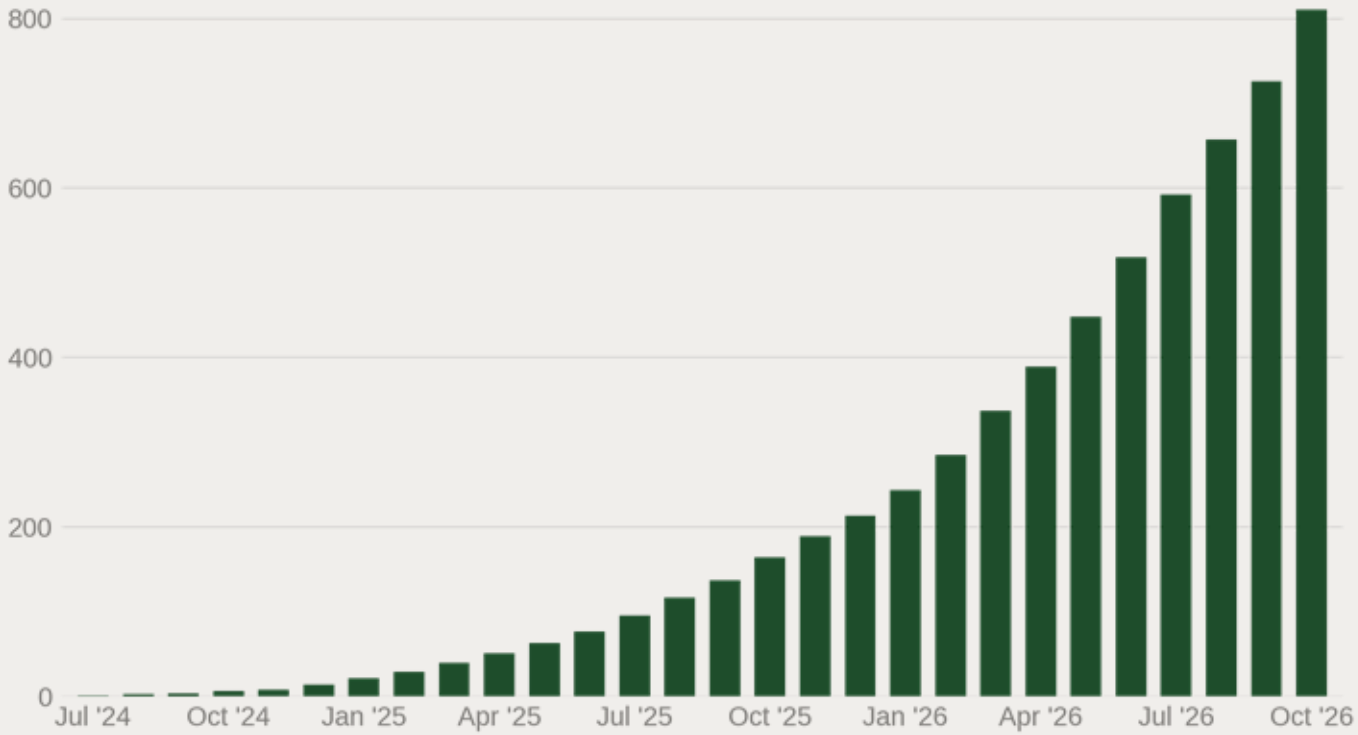
We network it into dispatchable capacity

24/7 dispatchable aggregations of batteries, controlled by the utility

We are on track to deploy 1 GWh of distributed batteries

INSTALLED CAPACITY

810 MWh



2,000+ installs per month

300+ MW under contract with utilities for 2026-27 delivery

60,000+ outages avoided for Base households

UTILITY PARTNERS

CoServ · Austin Energy · The Electric Company, El Paso Electric · gvec Delivering more. · Farmers Electric Cooperative · Rayburn Electric Cooperative · Central Georgia EMC

Our model is a win-win for utilities and their customers

UTILITY

Gets reliable capacity

Contracts with Base for a high-performance, fully dispatchable grid resource



Base deploys residential batteries

RESIDENTIAL CUSTOMER

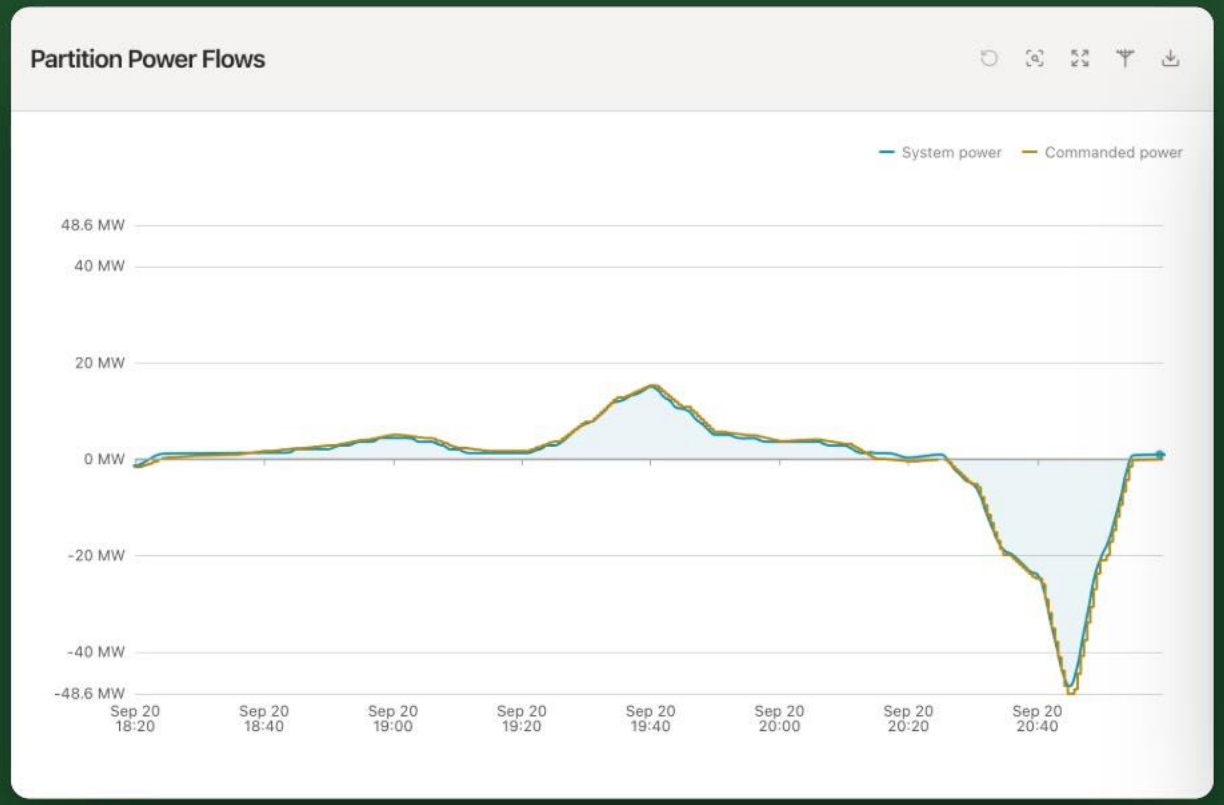
Gets cheap resiliency

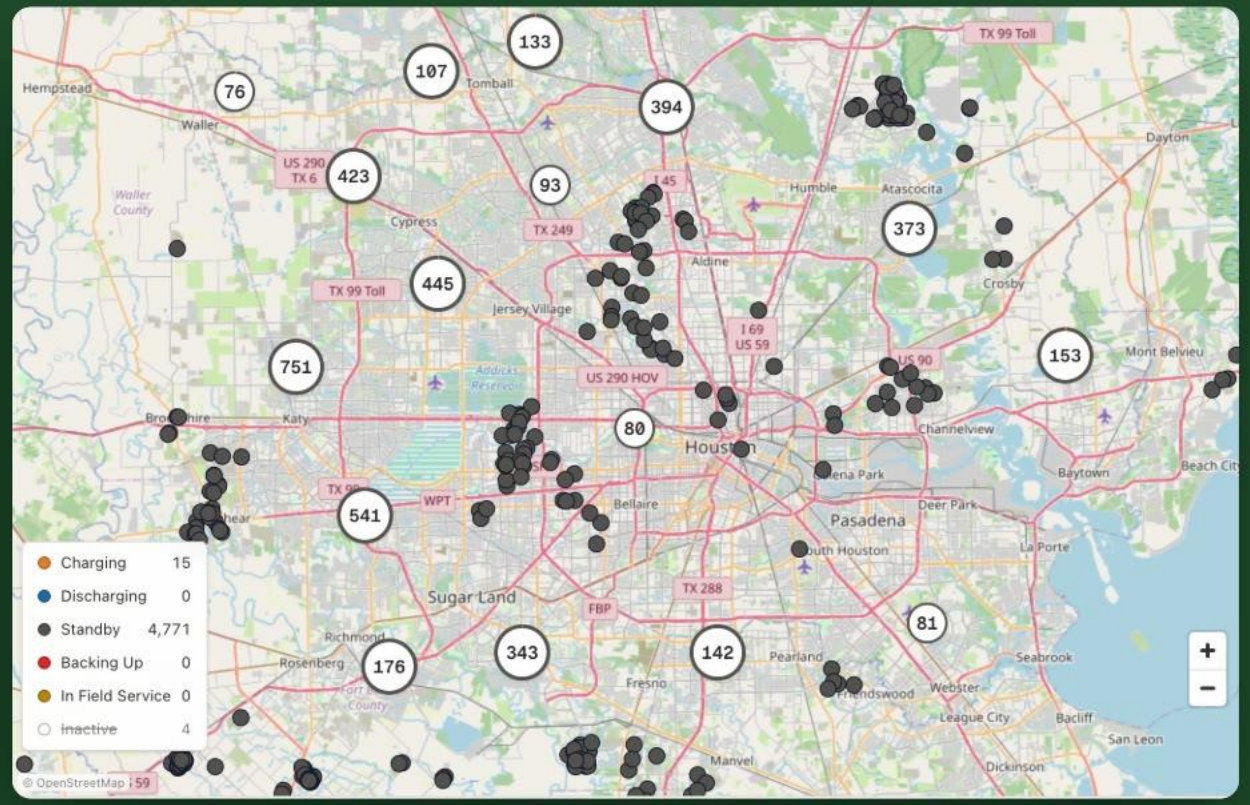
Enrolls with Base to receive home backup at 1/10th the cost of any other option

A high-performance grid asset, dispatchable in real time

lz-houston-ader Following ERCOT dispatch · Sep 20

8:59 PM CT





2 sec
response time

>96%
availability

>95%
dispatch accuracy

Base fleets can solve multiple grid needs for utilities

Bulk system capacity

Deliver accredited capacity to meet resource adequacy and peak shave to reduce system strain and lower costs

Austin Energy · CoServ

Delivering 150 MW of peaking capacity in 12 months

Distribution grid support

Deploy batteries on targeted circuits to relieve local grid constraints

The Electric Company · El Paso Electric

Deferring a substation upgrade with ~10 MW in under 5 months

Speed to power

Accelerate interconnection of large loads while providing affordability benefits to communities

Hyperscaler partner to be announced in Q1 2027

BYOC with $10/month bill credit for participating customers

Clarity in the face of complexity

Brattle

