

Breaking the Binary: Achieving Both Profitability and Performance in BESS

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Key challenges of BESS owners and operators today



Trapped capacity

**Operational
inefficiencies**

**Futureproofing
assets**

Why is determining a measure of “usable energy” so complex and important?

Standard system
with 20% buffer



Buffer is composed
of multiple
sources of
uncertainty

These buffers
account for
uncertainties in:

SoC inaccuracy >25%

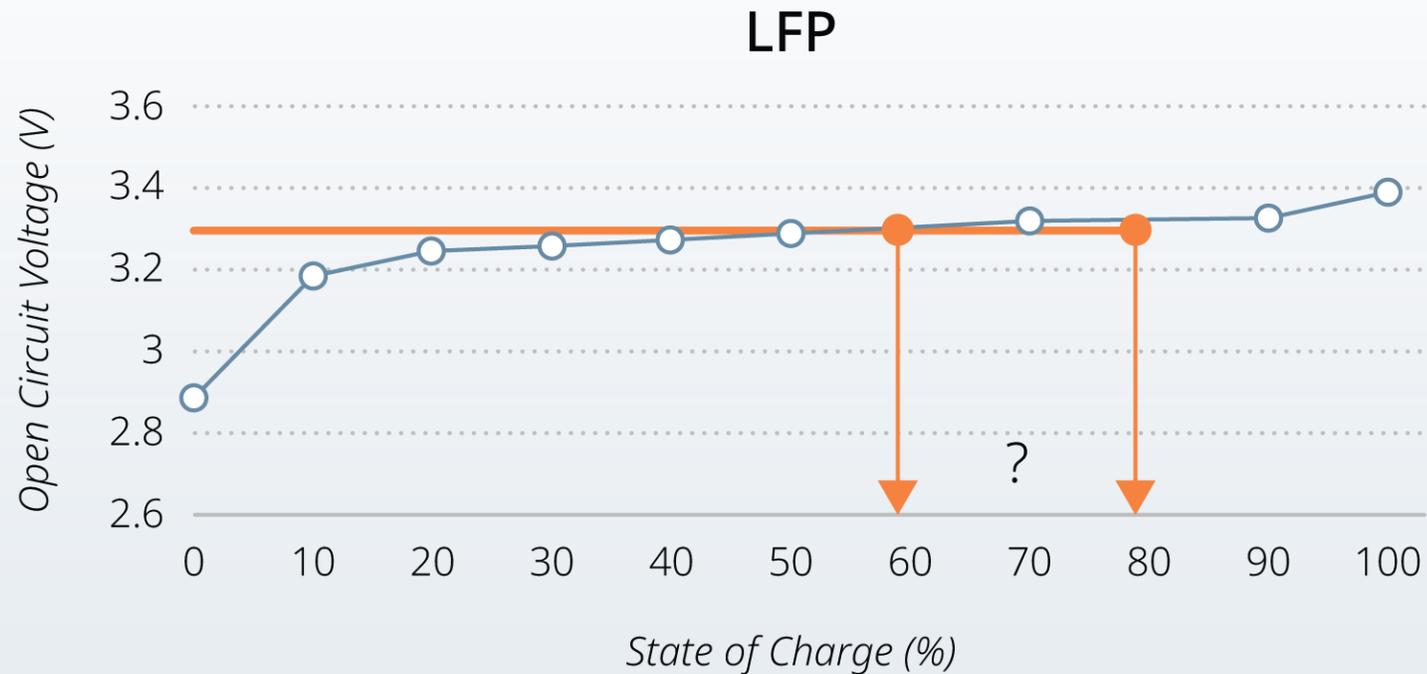
Cell imbalance >15%

Degradation

Unexpected unit level
outages

Why is determining a measure of “usable energy” so complex?

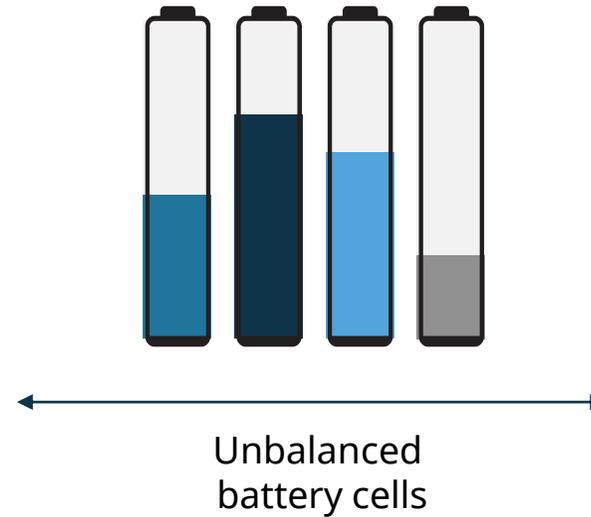
Accurately measuring state of charge is challenging due to the unique attributes of LFP batteries.



Why is determining a measure of “usable energy” so complex?

Measuring imbalance

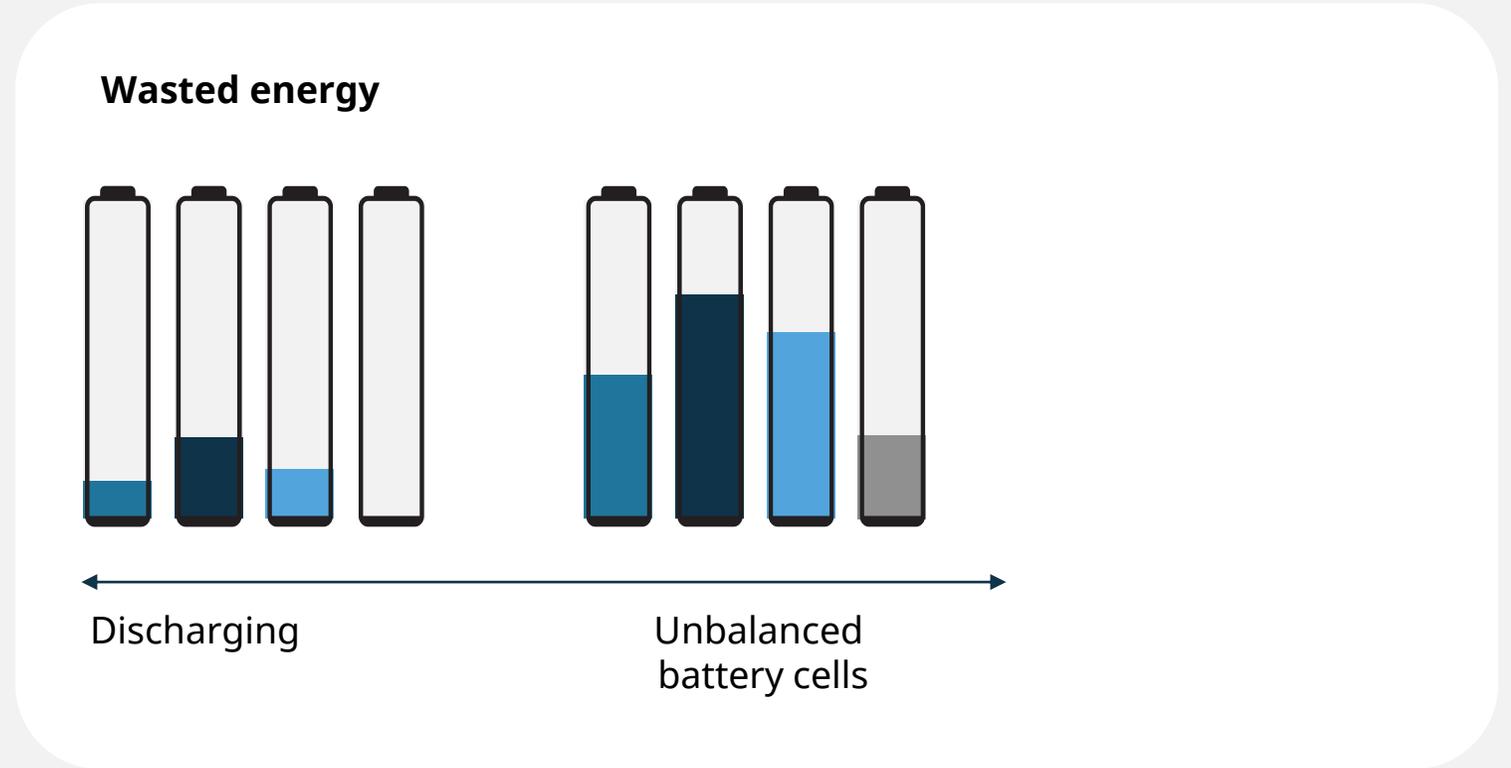
- Imbalance is caused by uneven voltage levels (or SoC percentage) in battery cells



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Measuring imbalance

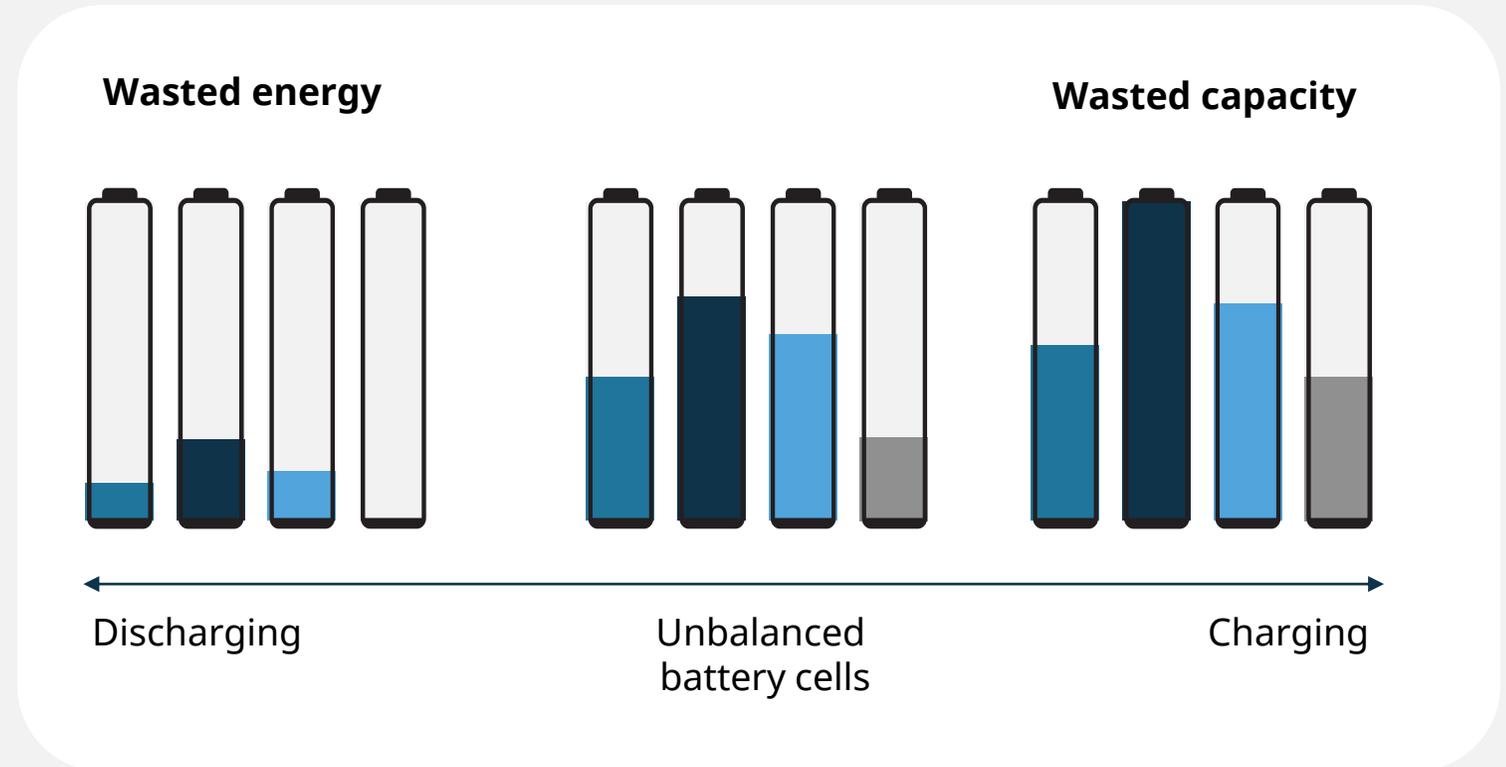
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Why is determining a measure of “usable energy” so complex?

Measuring imbalance

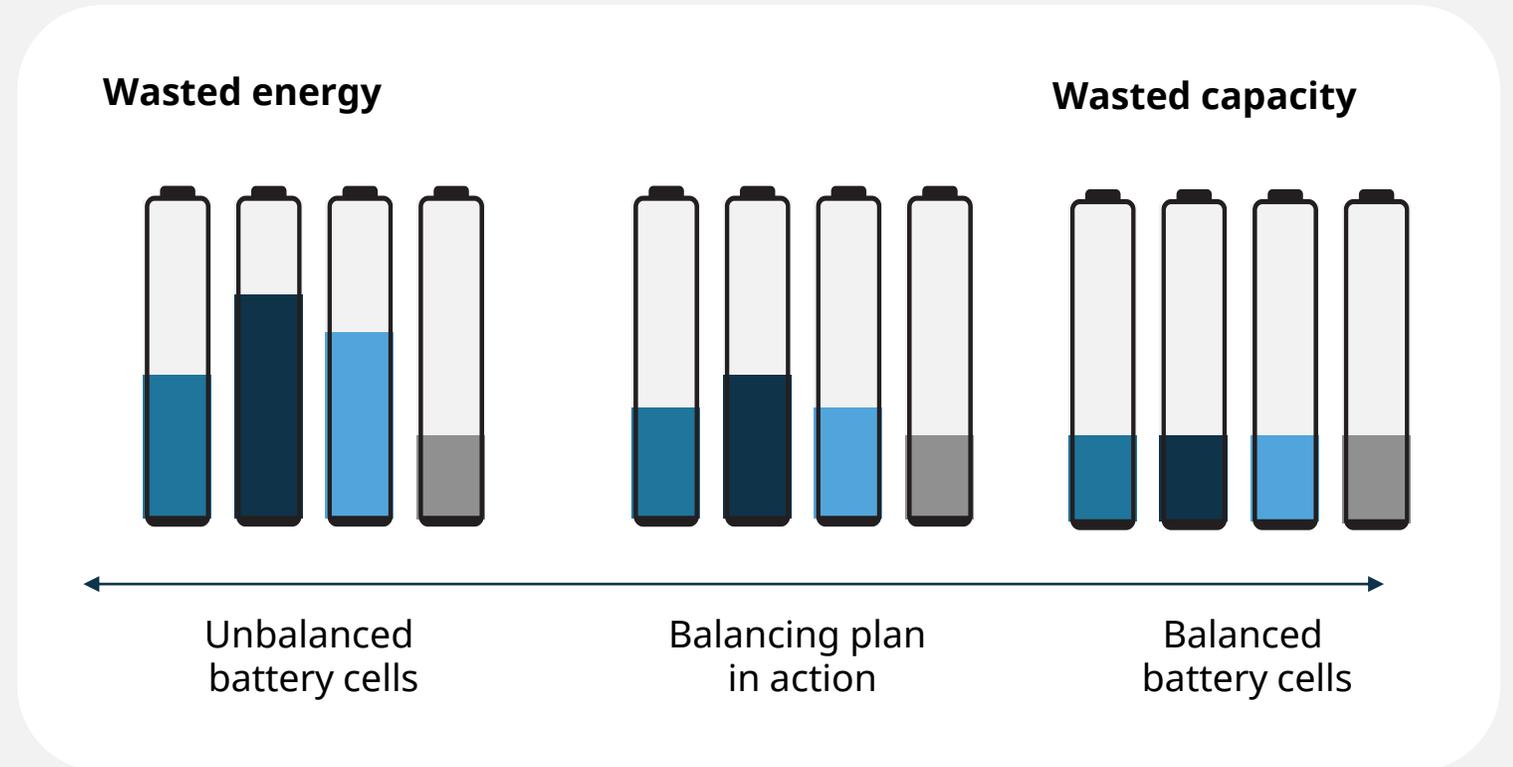
- Imbalance is caused by uneven voltage levels (or SoC percentage) in battery cells
- One imbalanced cell affects every cell in either the string or inverter, leading to significant energy loss
- Identifying the location of imbalance and measuring the impact is crucial to maintaining an optimised system



Why is determining a measure of “usable energy” so complex?

Resolving imbalance

- The BMS measures cell-level SoC and creates the balancing plan
- During operation and rest, the balancing plan is executed

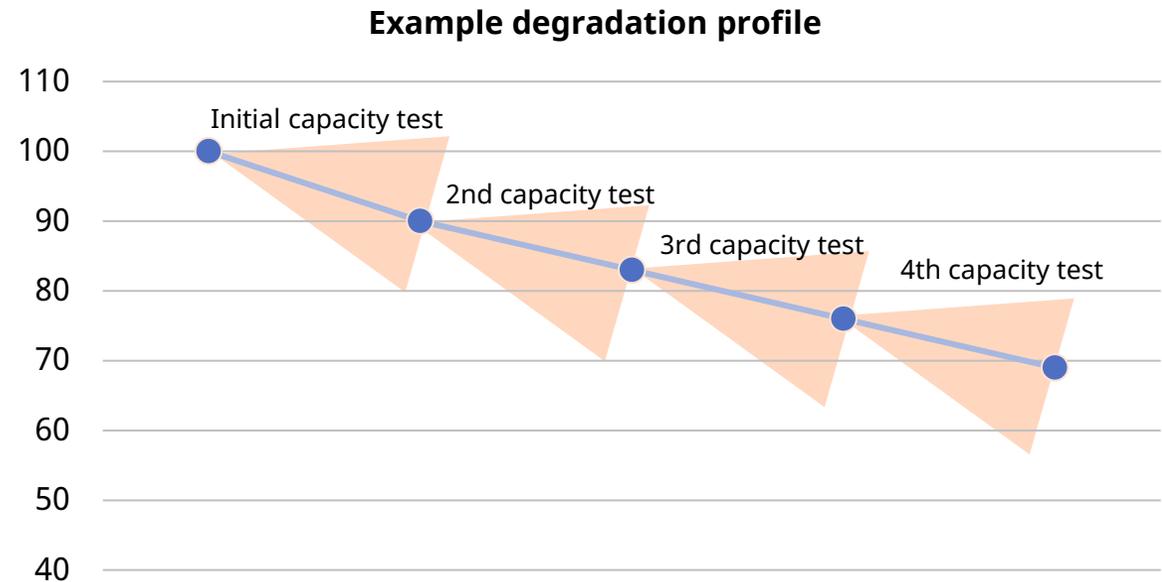


Why is determining a measure of “usable energy” so complex?

Understanding the degree of cell degradation

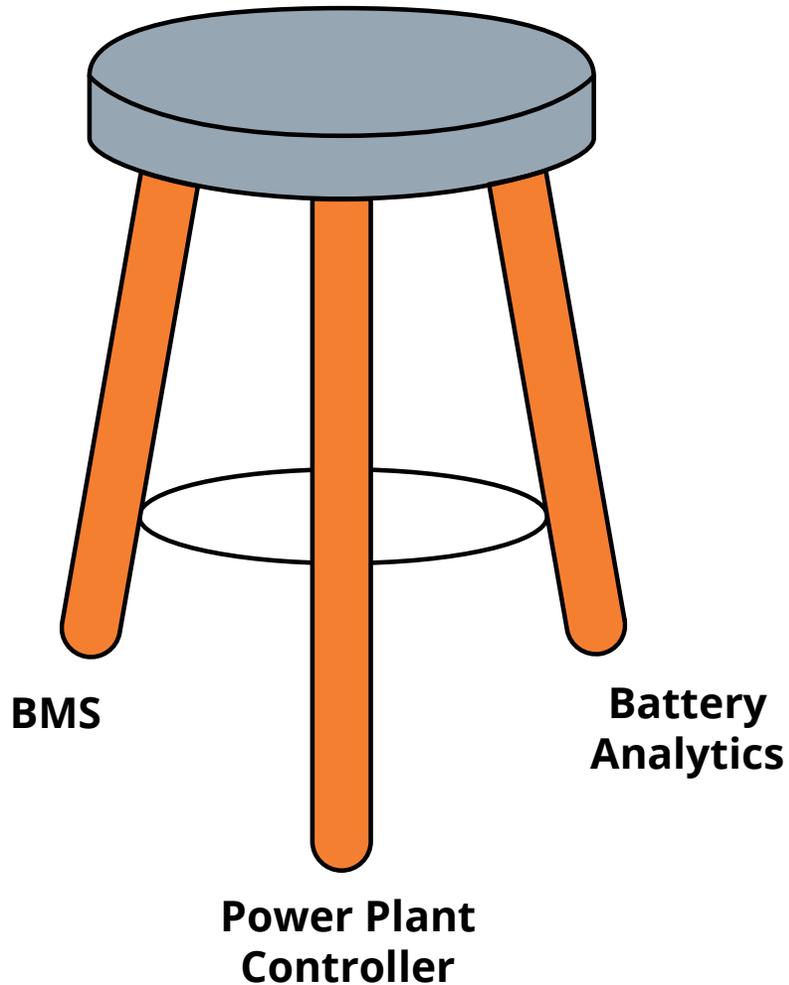
Degradation can be impacted by:

- Cycles/day
- CP rate
- Depth of discharge
- Resting state of charge
- Operating temperature



Our uniquely integrated solution

| Full integration enables market-leading capacity maximisation.

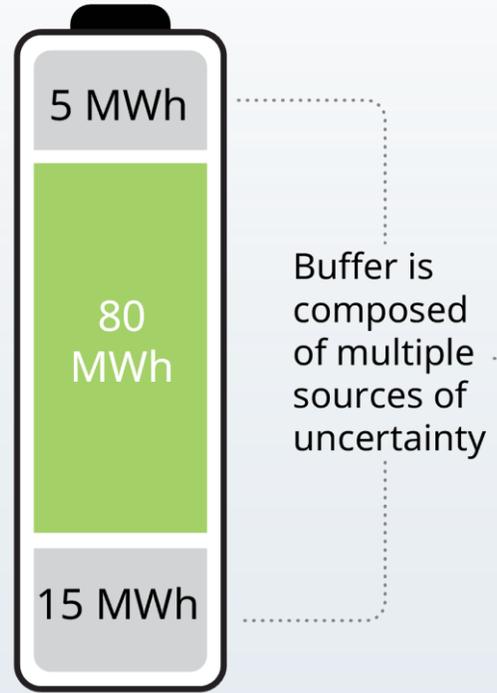


- › The **Wärtsilä BMS** estimates SoC and performs calibrations
- › **GEMS Power Plant Controller** determines when and how often calibrations happen
- › **GEMS Pulse** takes information from the BMS and Power Plant Controller to estimate current SoC error and recommends when a calibration should happen

Unlock trapped capacity

GEMS Pulse increases an asset's usable energy by providing certainty around SoC accuracy, imbalance, and degradation

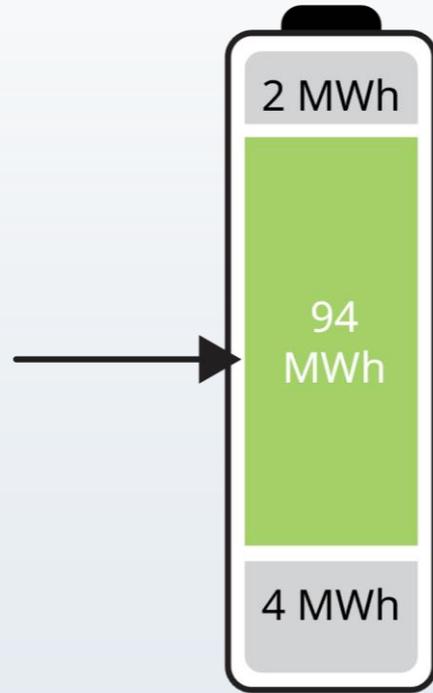
Standard system with 20% buffer



These buffers account for uncertainties in:

- SoC inaccuracy >25%
- Imbalance >15%
- Uncertain degradation
- Unexpected unit level outages

Systems with increased usable energy



= Increased revenue driven by GEMS Pulse & the Wärtsilä BMS's **real-time usable energy** calculation

What is “real-time usable energy”?

The amount of energy that can be discharged/charged by the BESS, accounting for battery state of charge, state of health, cell imbalance, and outages.

Financial impact

| Uncertainty leads to large revenue losses.

5% SoC error could cause
\$10/MW annual loss



On a 100 MW 2-hour system,
the revenue loss could be
>\$1M/year



This could end up costing
\$15M- \$20M
over the lifetime
of the asset

Key challenges of BESS owners and operators today



Trapped capacity

Operational inefficiencies

Futureproofing assets

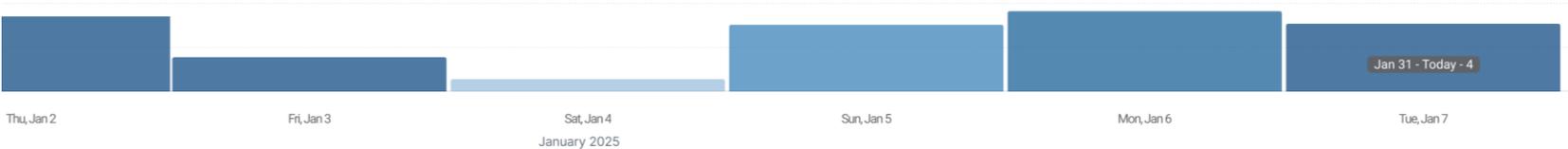
Optimise operations

GEMS Pulse anomaly detection helps maximise asset availability and capacity while reducing opex costs.

Metrics Outage Tracker Anomalies


OP


SCORE (i)



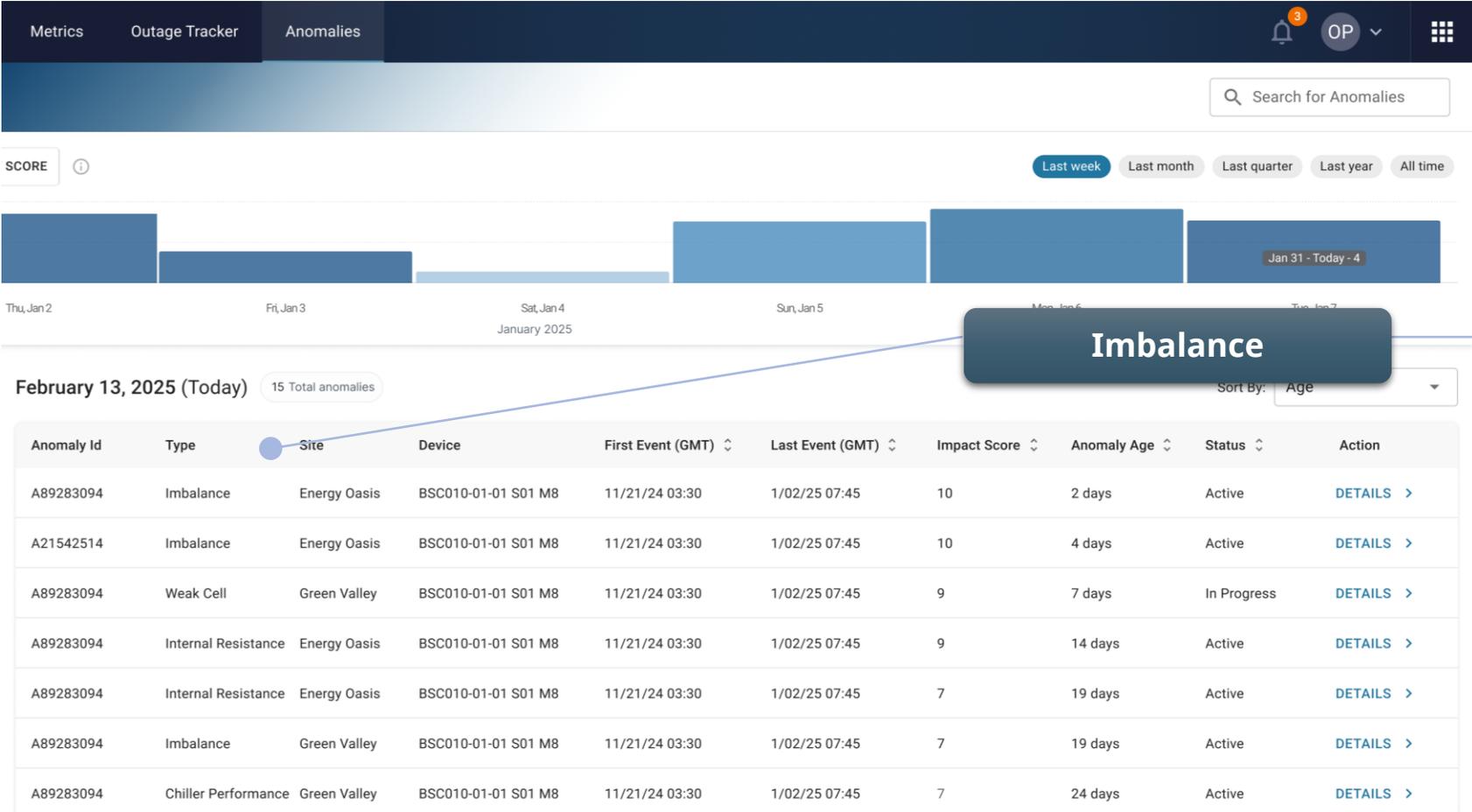
Last week Last month Last quarter Last year All time

February 13, 2025 (Today) 15 Total anomalies Sort By: Age

Anomaly Id	Type	Site	Device	First Event (GMT) ↕	Last Event (GMT) ↕	Impact Score ↕	Anomaly Age ↕	Status ↕	Action
A89283094	Imbalance	Energy Oasis	BSC010-01-01 S01 M8	11/21/24 03:30	1/02/25 07:45	10	2 days	Active	DETAILS >
A21542514	Imbalance	Energy Oasis	BSC010-01-01 S01 M8	11/21/24 03:30	1/02/25 07:45	10	4 days	Active	DETAILS >
A89283094	Weak Cell	Green Valley	BSC010-01-01 S01 M8	11/21/24 03:30	1/02/25 07:45	9	7 days	In Progress	DETAILS >
A89283094	Internal Resistance	Energy Oasis	BSC010-01-01 S01 M8	11/21/24 03:30	1/02/25 07:45	9	14 days	Active	DETAILS >
A89283094	Internal Resistance	Energy Oasis	BSC010-01-01 S01 M8	11/21/24 03:30	1/02/25 07:45	7	19 days	Active	DETAILS >
A89283094	Imbalance	Green Valley	BSC010-01-01 S01 M8	11/21/24 03:30	1/02/25 07:45	7	19 days	Active	DETAILS >
A89283094	Chiller Performance	Green Valley	BSC010-01-01 S01 M8	11/21/24 03:30	1/02/25 07:45	7	24 days	Active	DETAILS >

Optimise operations

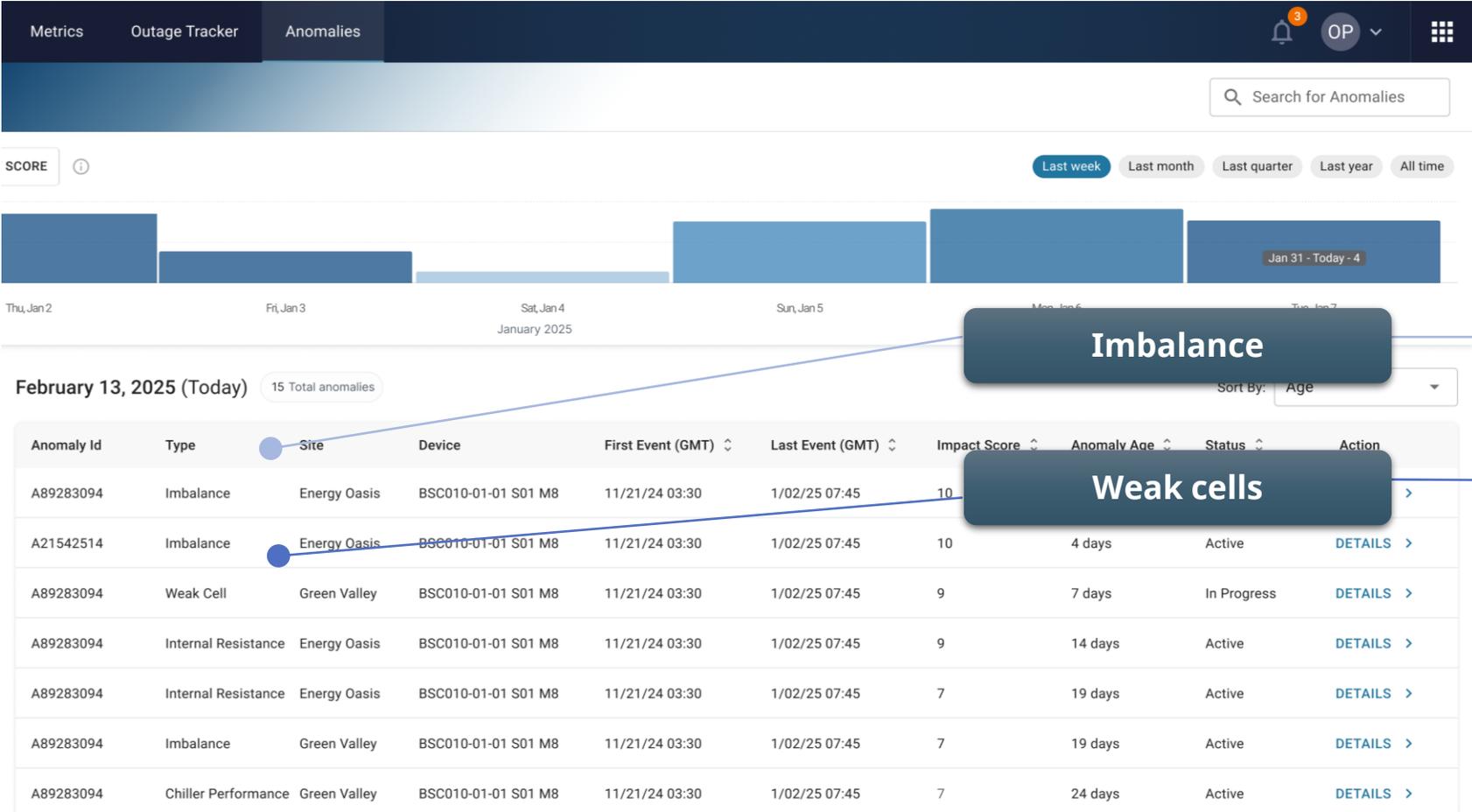
GEMS Pulse anomaly detection helps maximise asset availability and capacity while reducing opex costs.



Reduces usable capacity by up to 15%

Optimise operations

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Imbalance

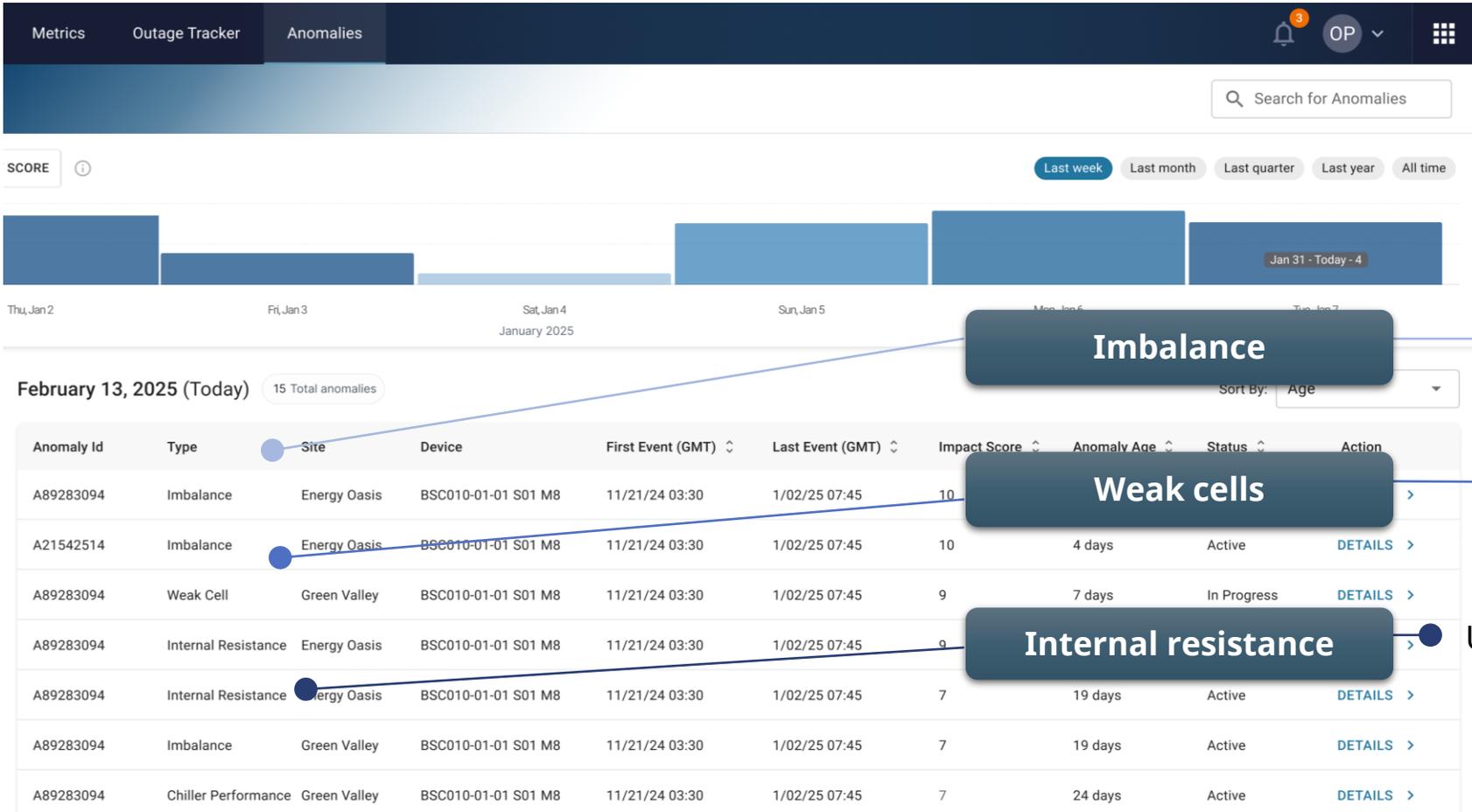
Reduces usable capacity by up to 15%

Weak cells

Reduces usable capacity by up to 5%

Optimise operations

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Imbalance

Reduces usable capacity by up to 15%

Weak cells

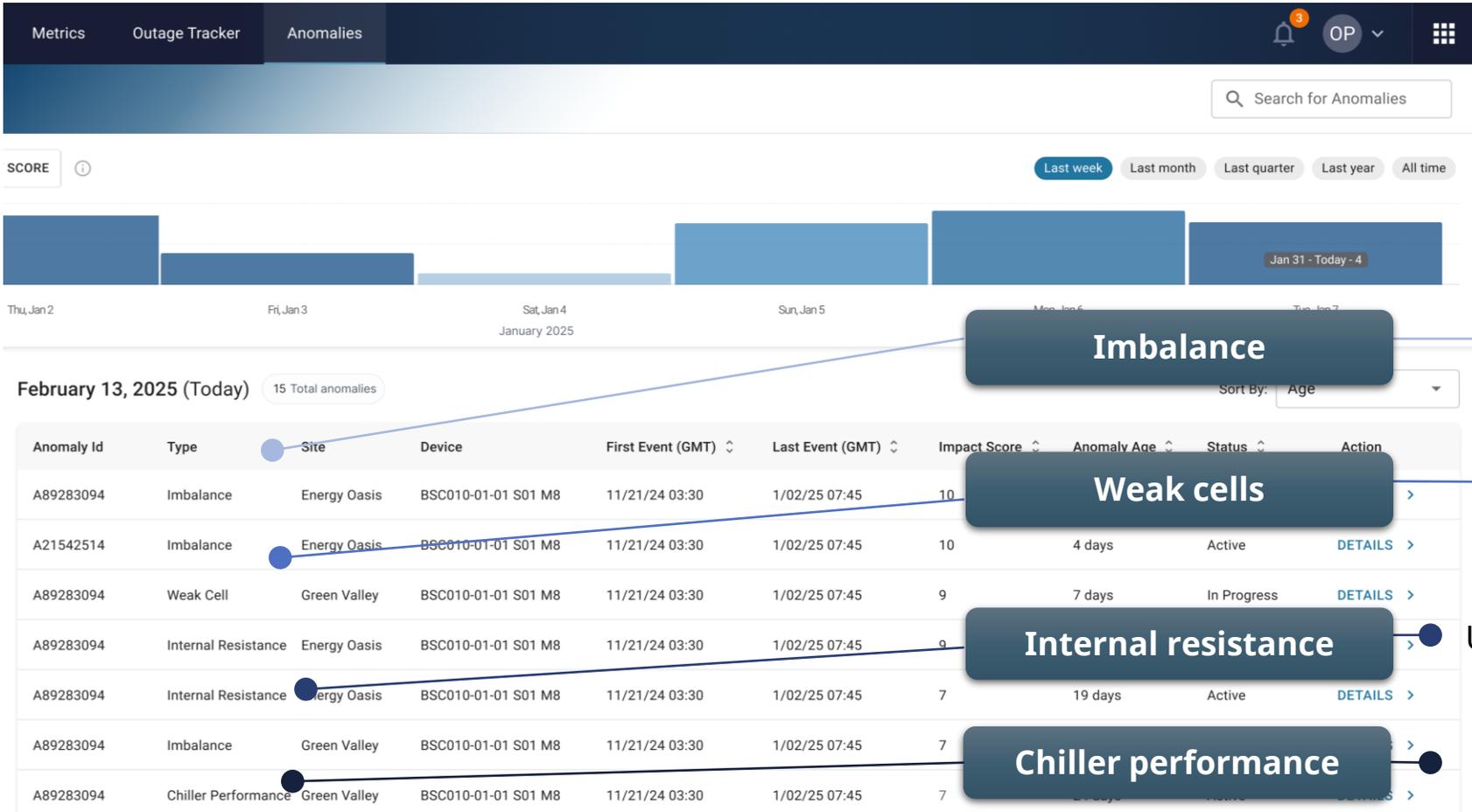
Reduces usable capacity by up to 5%

Internal resistance

Uneven degradation, unexpected downtime

Optimise operations

GEMS Pulse anomaly detection helps maximise asset availability and capacity while reducing opex costs.



Imbalance

Reduces usable capacity by up to 15%

Weak cells

Reduces usable capacity by up to 5%

Internal resistance

Uneven degradation, unexpected downtime

Chiller performance

Uneven degradation, unplanned truck rolls

Key challenges of BESS owners and operators today



Asset operators can now understand the impact of dispatch strategies on degradation, warranty, and asset efficiency to optimise the lifetime value of assets.

Futureproof assets

- CYCLES PER DAY = 1.25
- OPERATING TEMPERATURE = 25 °C
- CP RATING = 0.50
- DEPTH OF DISCHARGE = 80%

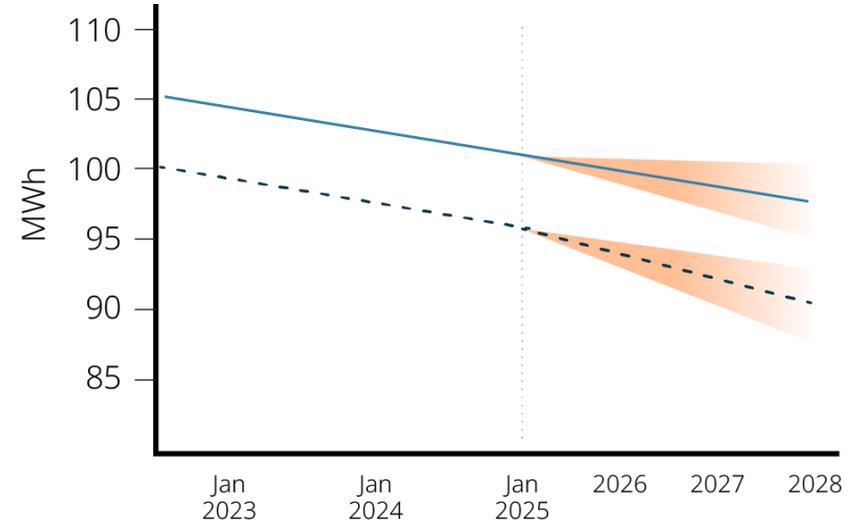
INPUTS

OUTPUTS

- DEGRADATION FORECAST
- FLEXIBLE PERFORMANCE GUARANTEE FORECAST
- OPERATING SUGGESTIONS TO MAXIMISE LTSA GUARANTEES



CAPACITY FORECAST



Thank you!

Steve Merrick
Senior Product Manager
Wärtsilä Energy Storage





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