Strategies + Synergies

RESILIENCE, PASSIVE DESIGN, & SMART GRID OPTIMIZATION

Presented by:
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PAE

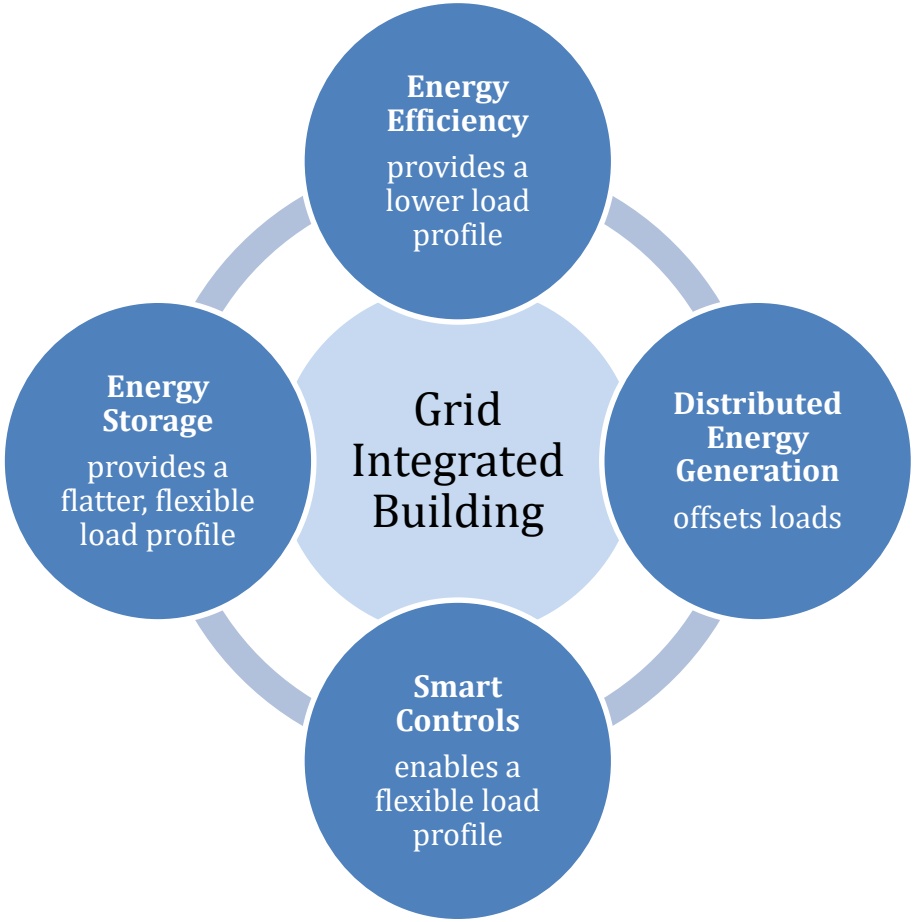
LEARNING OBJECTIVES

- Not all EUIs are created equal: participants will learn about the time-of-use implications of energy relative to its global warming impact and applications to projects.
- Emerging technology: participants will learn about new trends in energy storage and how this can be integrated into renewable energy systems for better payback and resiliency.
- Participants will learn how passive design strategies relate to a building’s load profile and therefore it’s impact on both global warming and resilience.
- Participants will learn about strategies to address resilience for critical facilities and general office buildings, including continuity of operations during extreme circumstances.

WHAT IS A GRID-INTEGRATED BUILDING?

Grid-Integrated Buildings have a holistically optimized blend of energy efficiency, distributed energy generation, load flexible technologies/smart controls, and energy storage.

- Create a lower, “flatter”, more flexible energy load profile
- Have flexible demand
- Are more resilient and productive
- Optimize capital investments
- Reduce operating costs
- Provide access to new revenue for both building owners and utilities



https://www.gsa.gov/cdnstatic/Bldg%20Grid%20Integration%20Advice%20Letter%202-21-19%20-%20508.pdf

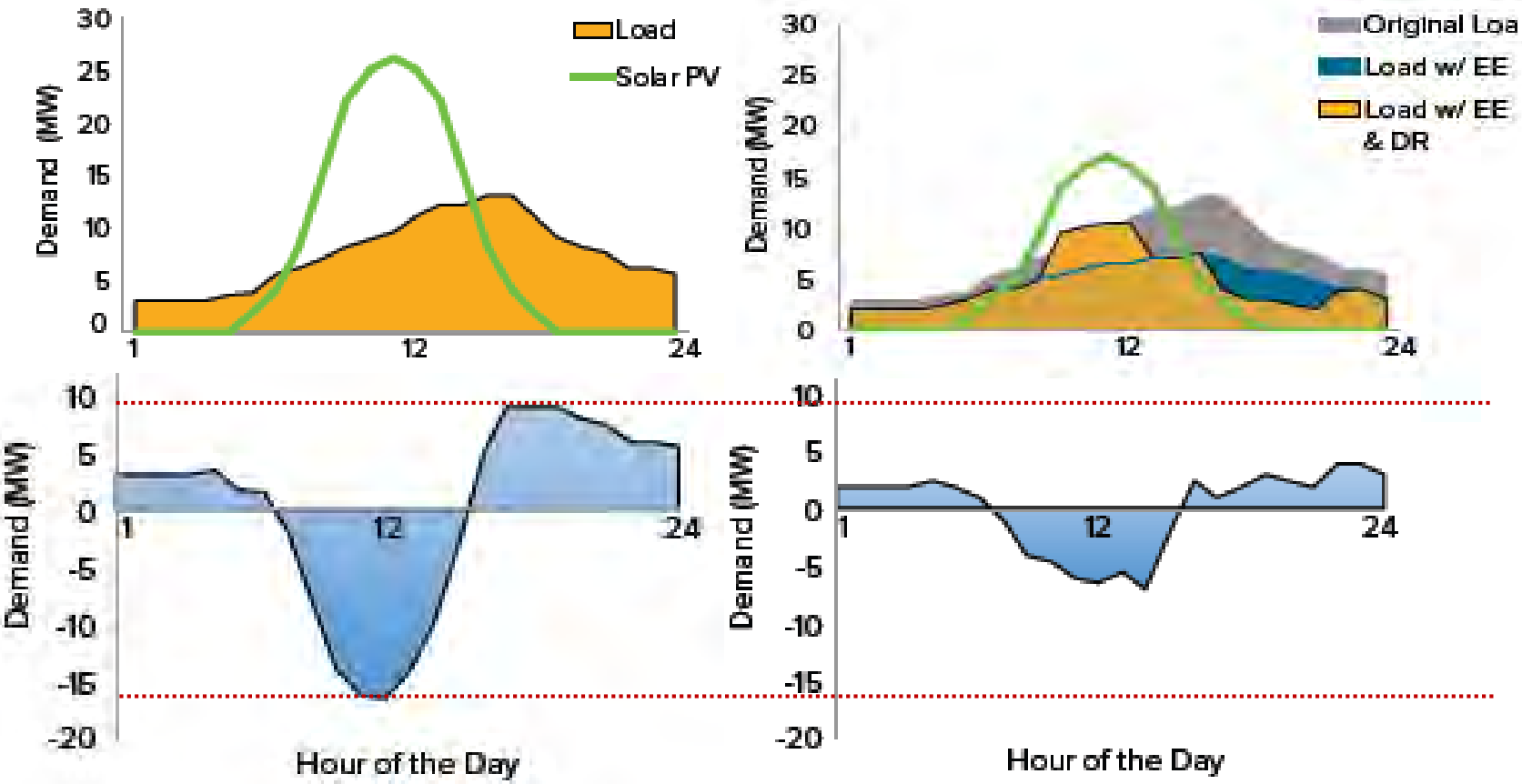
ZERO ENERGY WITH AND WITHOUT GRID INTEGRATION

Load Shape

Grid Impact

Solar PV only

Energy Efficiency, Demand Response + Solar PV



Courtesy: NREL, RMI

GRIDOPTIMAL™ BUILDINGS INITIATIVE

https://newbuildings.org/gridoptimal/

Owner’s Goals

PROGRAMMATIC & FUNCTIONAL REQUIREMENTS

- Continuous operations
- Security
- Eliminate single points of failure

ORGANIZATIONAL & EMPLOYEE NEEDS

- Employee recruitment & retention
- Health & wellbeing
- Productivity

RESOURCE USE

- Minimize operational cost
- Reduce carbon footprint
- Accountability & value to stakeholders

Climate + Site Analysis

SITE SELECTION

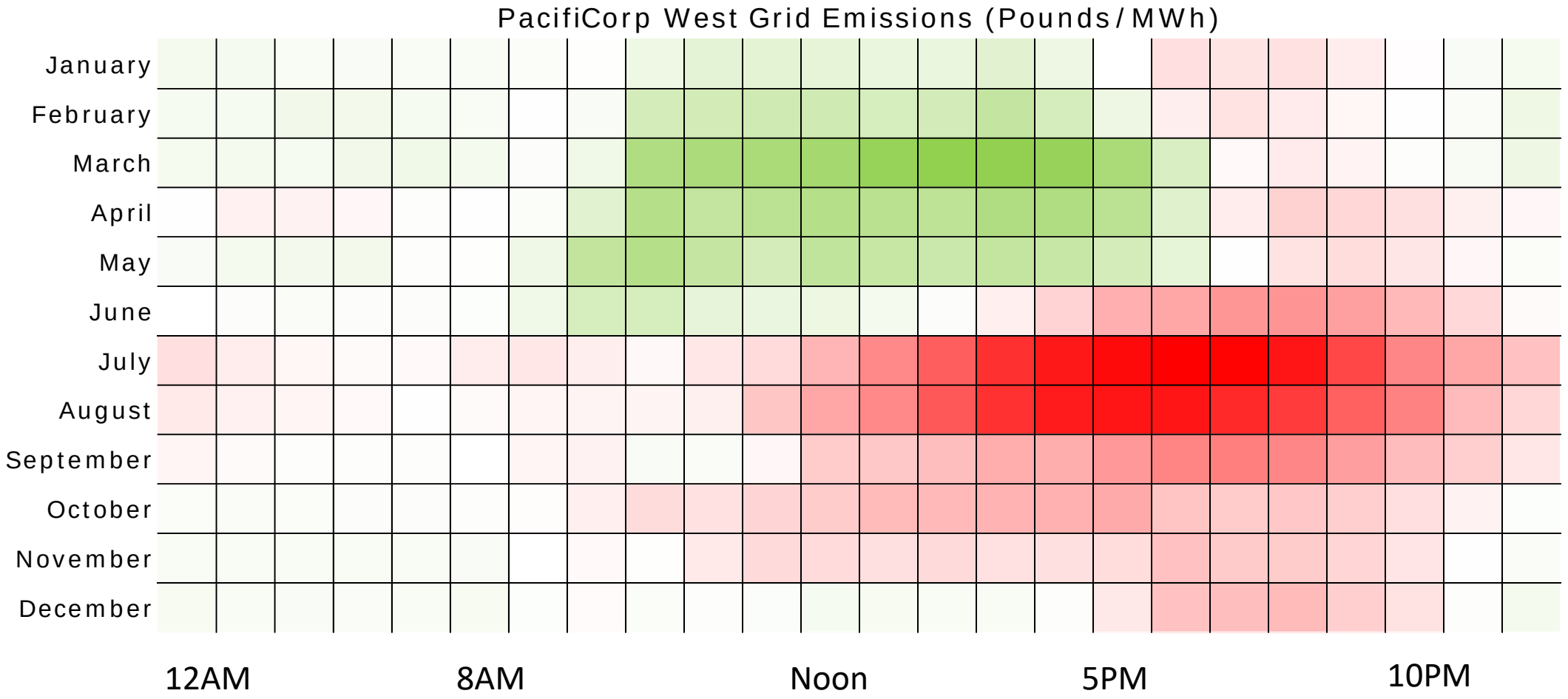
OPPORTUNITIES

CHALLENGES

NORTHWEST CLIMATE

STRATEGIES FOR EFFICIENCY

Battery CO2 Impact



Modes of Operation

Resiliency design for daily and disruptive events

NORMAL

Operational Efficiency

Operations Budgets

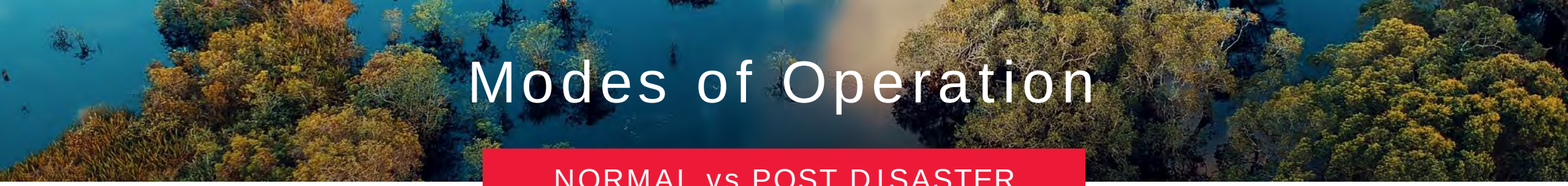
Employee Comfort

TEMPORARY & LONG TERM OUTAGE

Security Breach

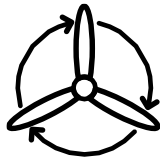
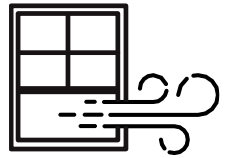
Power Supply Disruption

Earthquake



Modes of Operation

NORMAL vs POST DISASTER

	Normal Mode of Operation		Post-Disaster Mode of Operation	
OCCUPANTS	Normal Business Hours Fully Occupied	After Business Hours Critical Staff Only	All Hours Critical Staff Only	
THERMAL COMFORT	68°F to 75°F		65°F to 80°F	
VENTILATION	Automated		Manually Available	
LIGHTING	Fully Available		Reduced Levels	
ELECTRICAL POWER	Fully Available		Reduced Levels	

Load Reduction

HOW WE REDUCE LOADS

- Massing
- Orientation
- Daylighting
- Solar Control
- Thermal & Infiltration Performance
- Thermal Mass
- Operable Windows
- Natural Ventilation Shafts
- Heat Recovery
- Economizer
- Demand Control


Backup Power

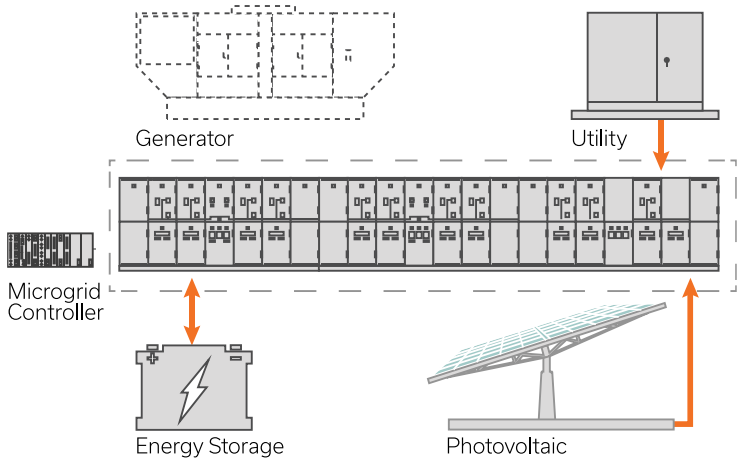
Generators
& Fuel Storage

PV &
Battery Storage

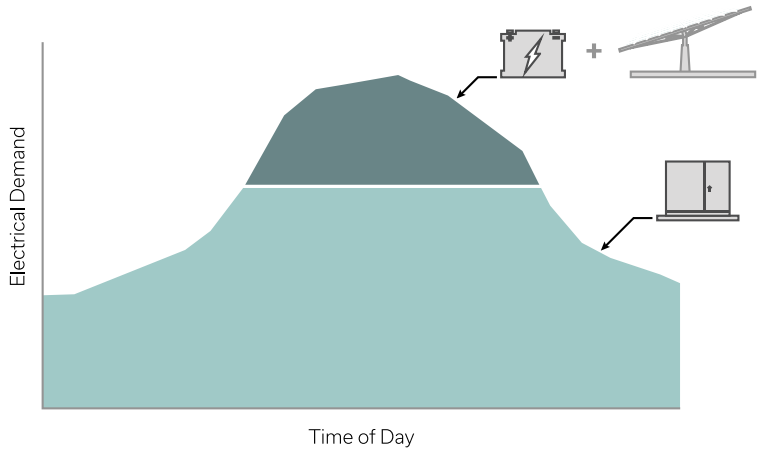
Microgrid

Microgrid + Energy Storage

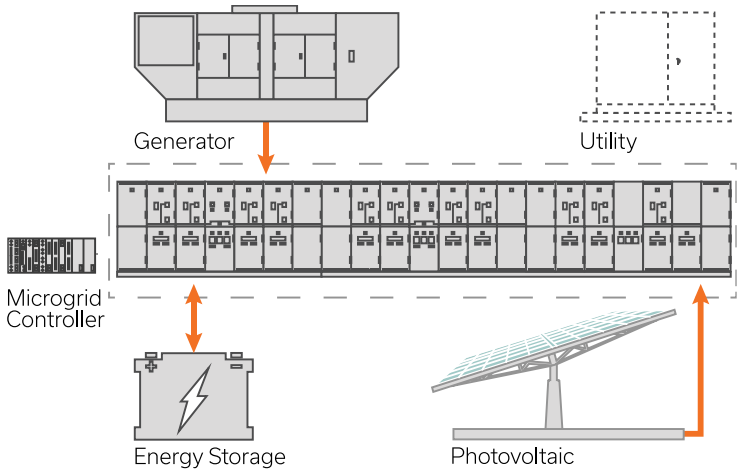
NORMAL



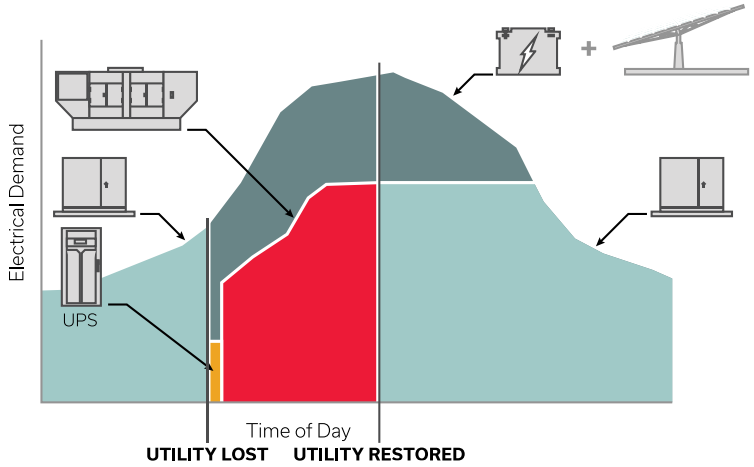
Peak Shaving



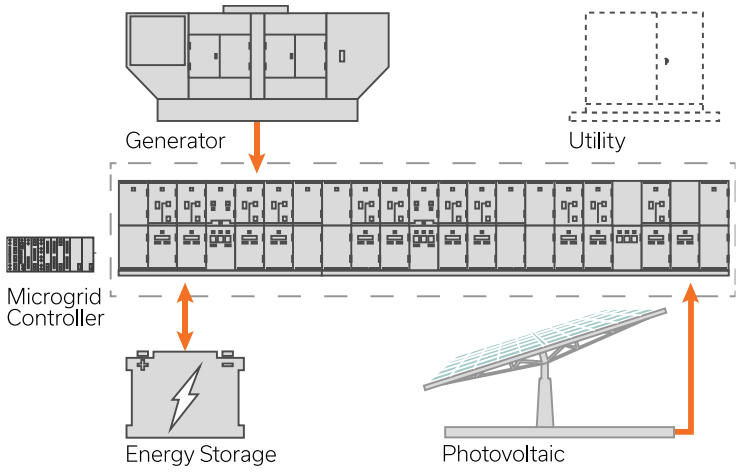
SHORT-TERM OUTAGE



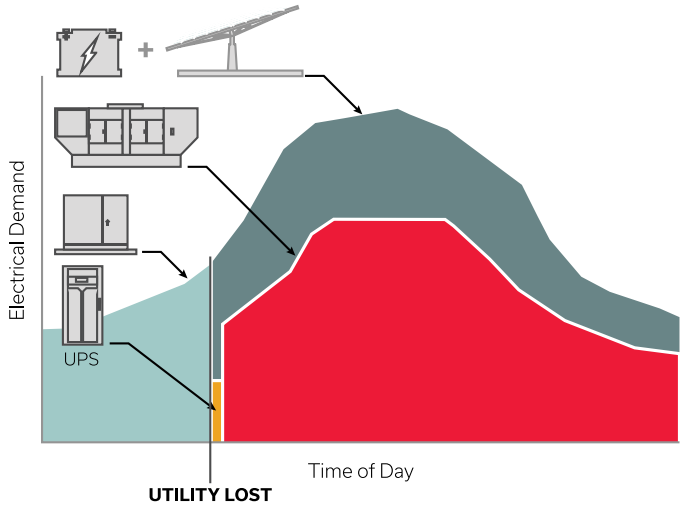
PV & Energy Storage Disabled **During** Outage



LONG-TERM OUTAGE

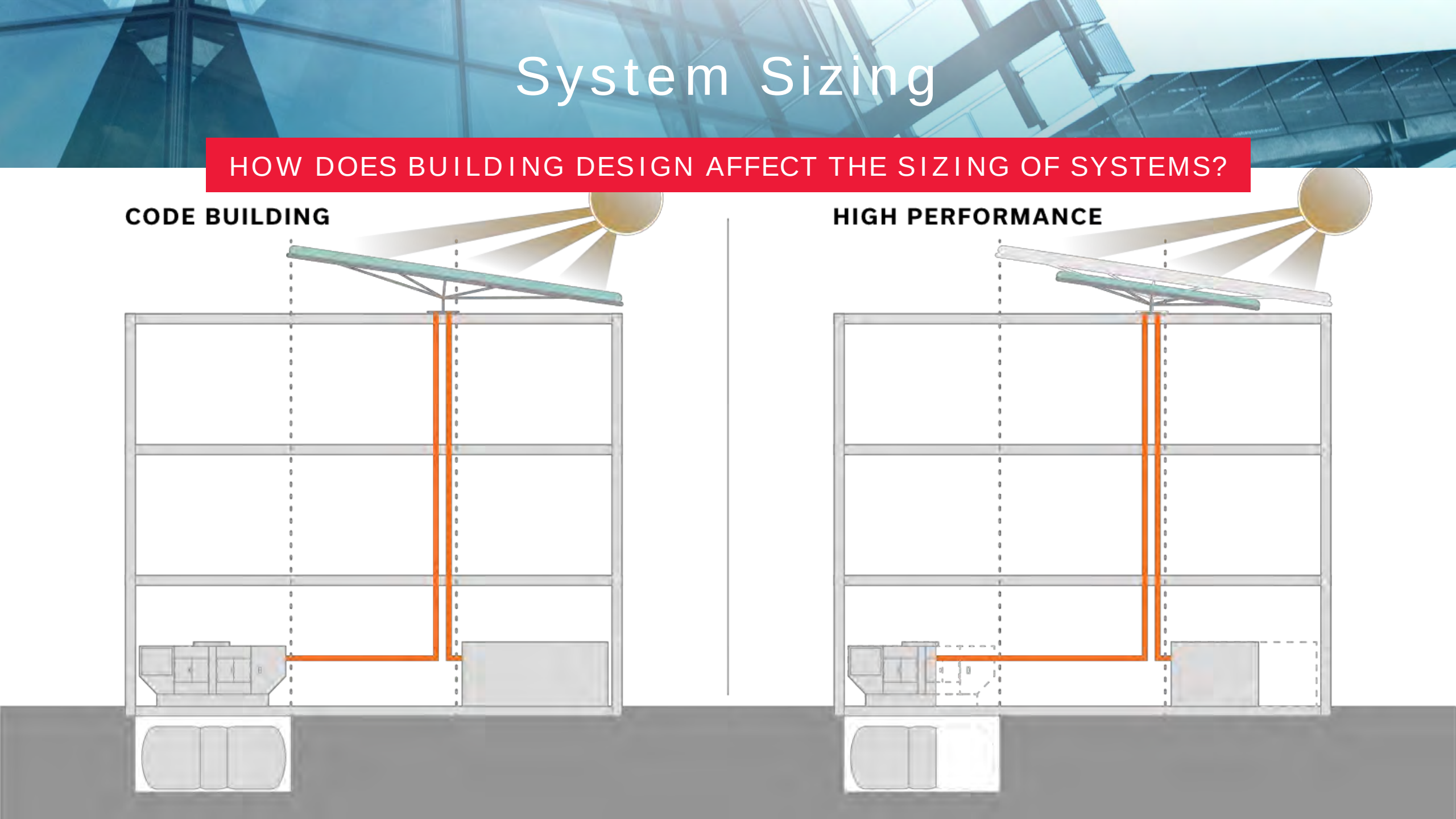


PV & Energy Storage Disabled **After** Outage



System Sizing

HOW DOES BUILDING DESIGN AFFECT THE SIZING OF SYSTEMS?



Resiliency for Non-critical Buildings

Business Continuity

Internal Benefits

MAINTAIN STAFF PRODUCTIVITY

MAINTAIN BUSINESS OUTPUT

SUPPORT STAFF
Sanctuary in an event

SUPPORT BRAND
Perception as Community Support

Office Building Example

STATS
58,000 SF
4 Floors of Office
1 Floor Retail

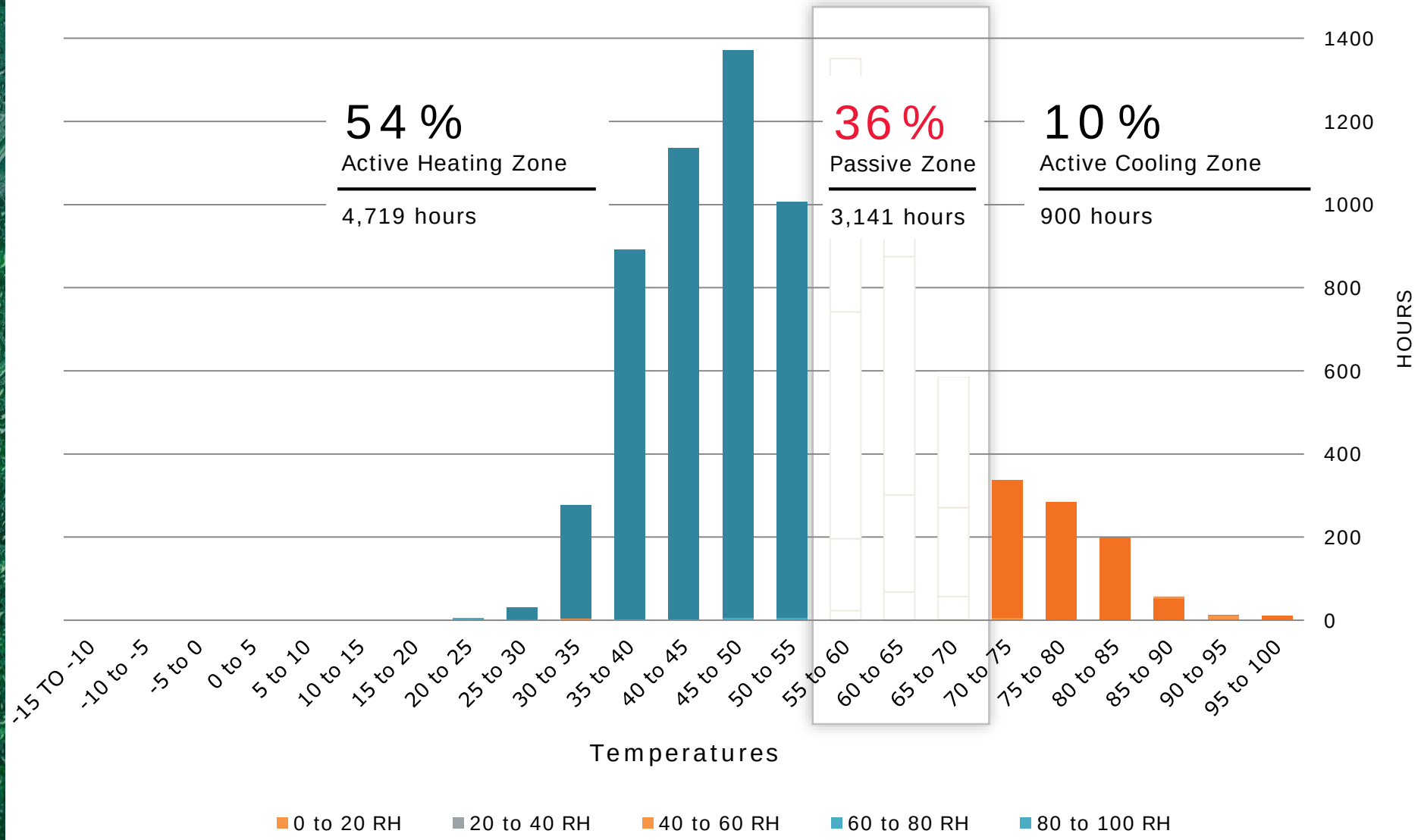
BENCHMARKS
Living Building
Net Zero Energy & Water

ENERGY
- 19 EUI
- 325 kW PV Array for Net Zero Energy
- 160 kWh Battery required for LBC

PASSIVE FEATURES
- High performance envelope
- Manual and automatic windows
- All occupied spaces within 10' of an operable window
- Designed for maximum daylighting

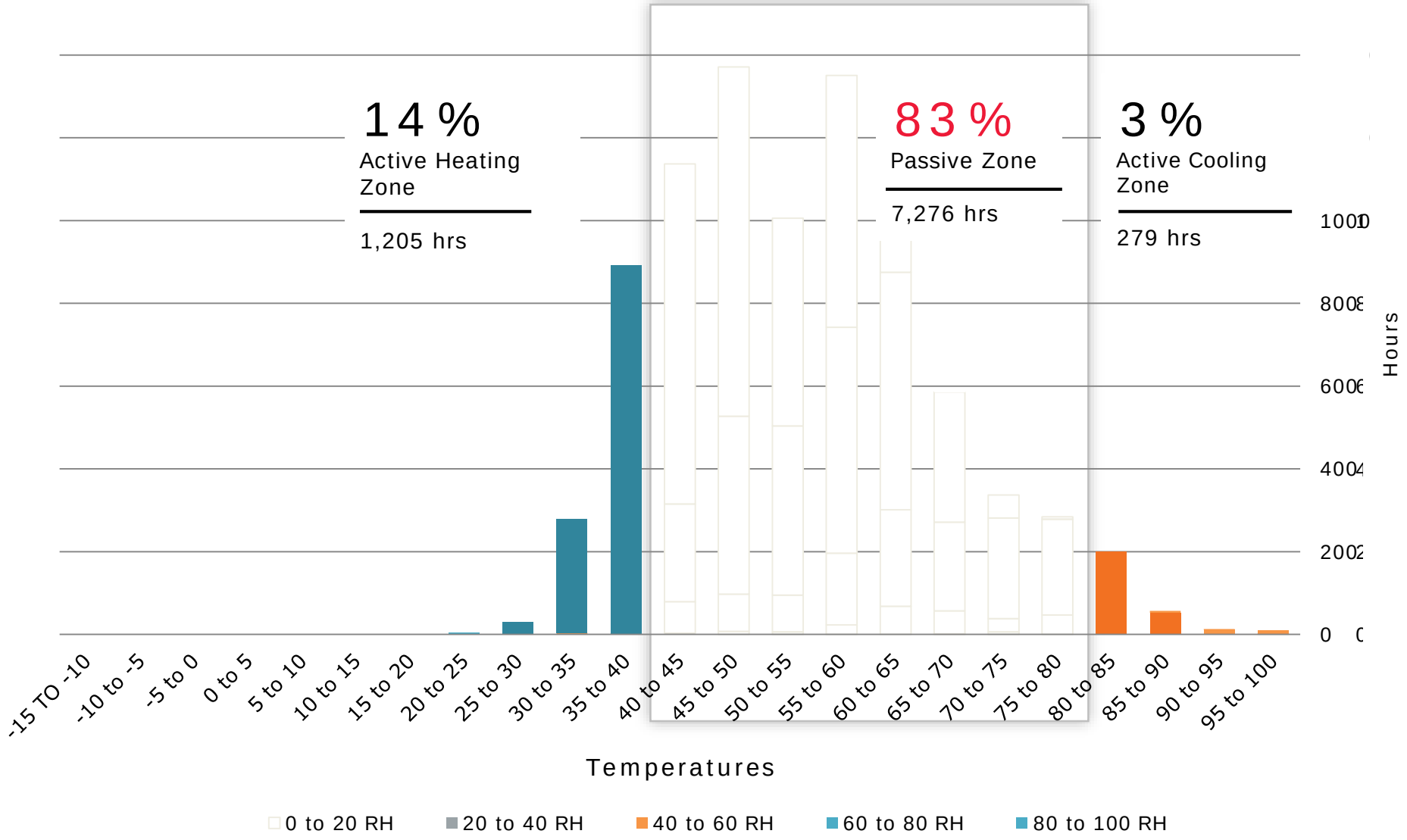
Passive Opportunities

Climate Analysis | Temperature Bins Portland

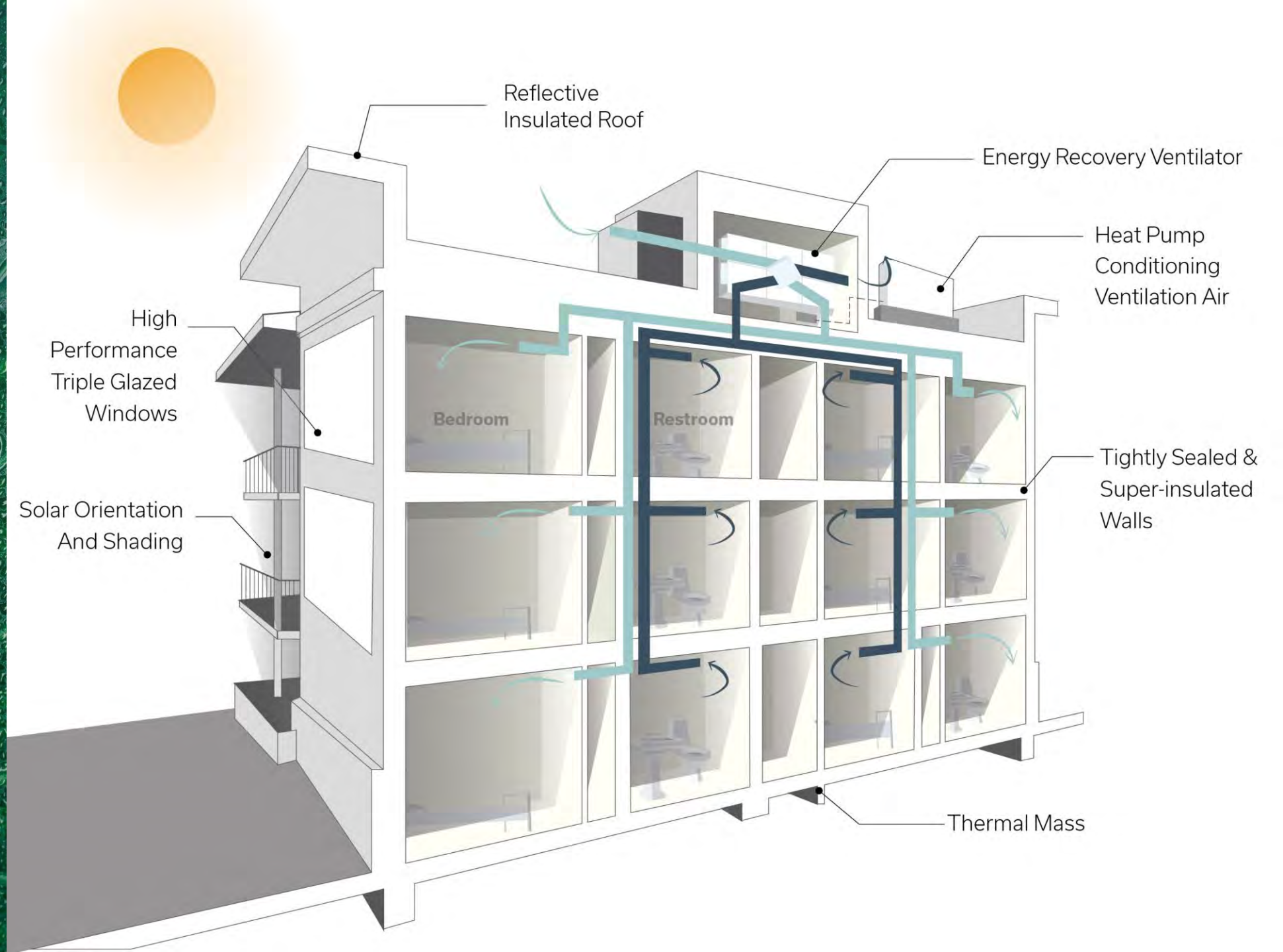


Passive Opportunities

Climate Analysis | Temperature Bins Portland



Passive Design

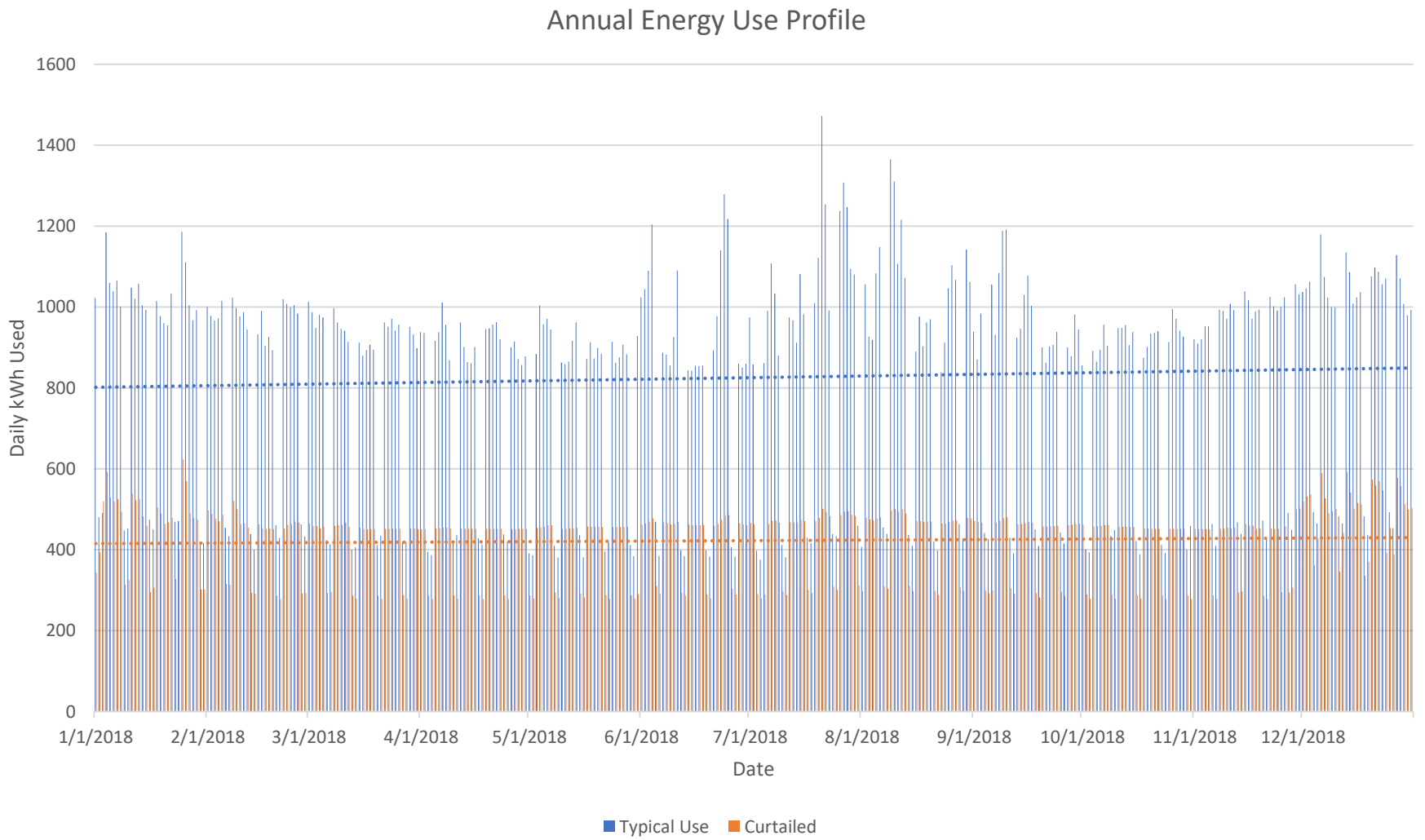


Business Continuity

OFFICE BUILDING EXAMPLE

Curtailment Strategies:

- Lights off
- Temperature set back
- Ventilation off
- Plug loads reduced to laptops only
- Elevator not used
- Only cold domestic water



Curtailment Strategies

- Lights Off
- Temperature Set Back
- Ventilation Off

Passive Design Features

70%

OF REDUCTION

- Plug Loads reduced to laptops only
- Elevator not used
- Cold Domestic Water Only

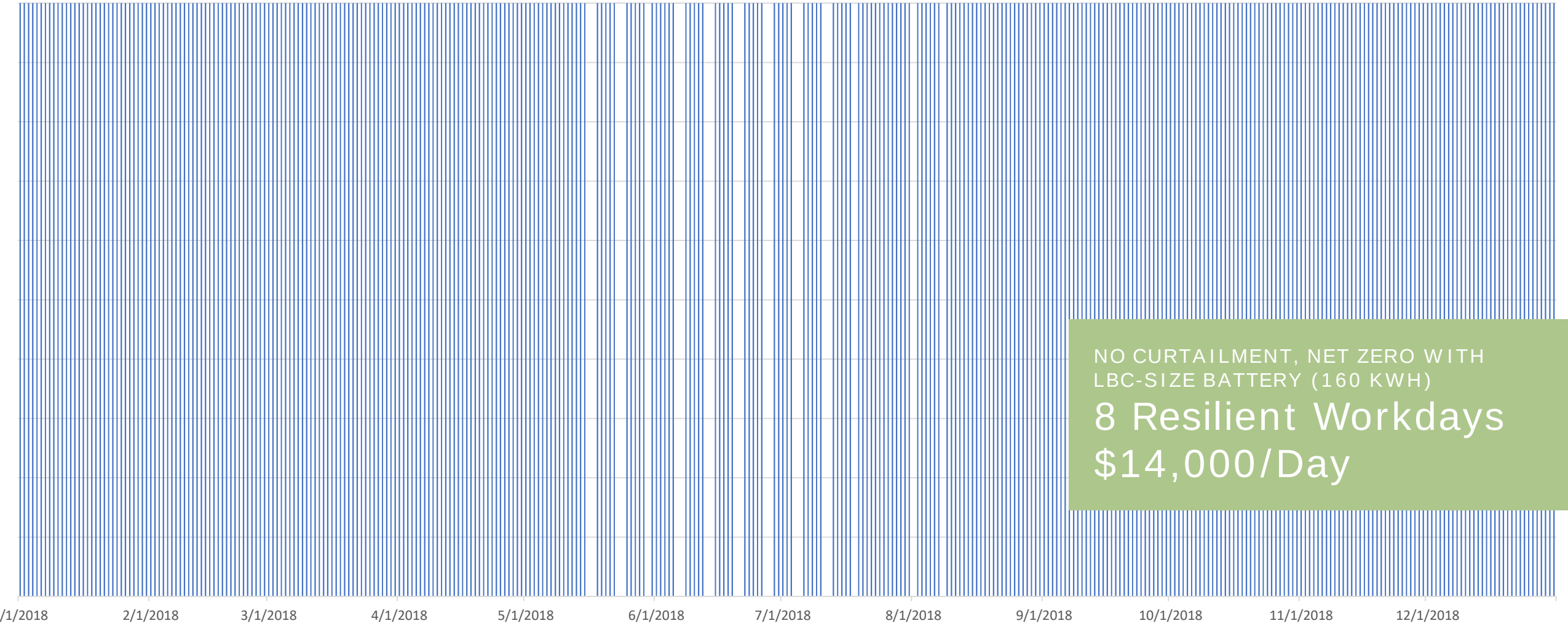
Usage curtailment

30%

OF REDUCTION

Business Continuity

DAYS AT RISK OF AN EMPTY BATTERY WHEN ISLANDING



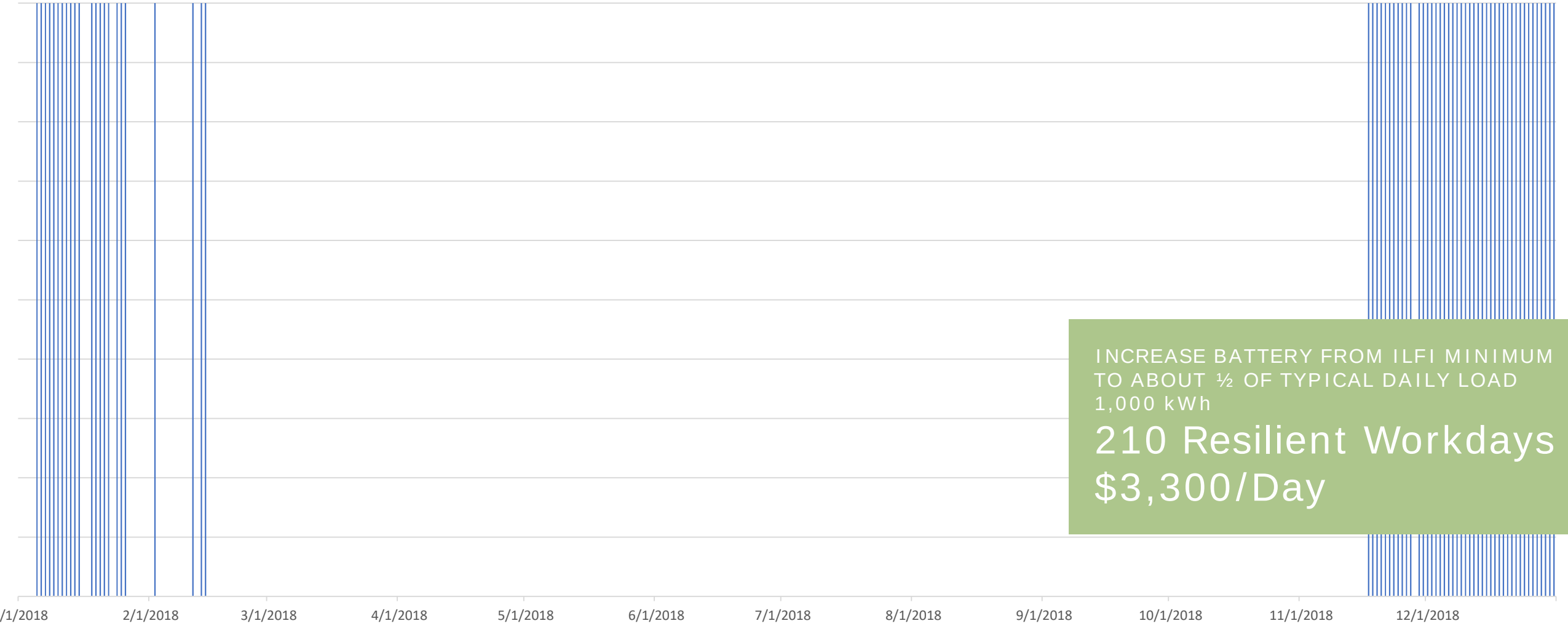
NO CURTAILMENT, NET ZERO WITH LBC-SIZE BATTERY (160 KWH)

8 Resilient Workdays

$14,000/Day

Business Continuity

DAYS AT RISK OF AN EMPTY BATTERY WHEN ISLANDING



INCREASE BATTERY FROM ILFI MINIMUM TO ABOUT ½ OF TYPICAL DAILY LOAD
1,000 kWh

210 Resilient Workdays

$3,300/Day

Business Continuity

DAYS AT RISK OF AN EMPTY BATTERY WHEN ISLANDING

ELIMINATING CURTAILMENT

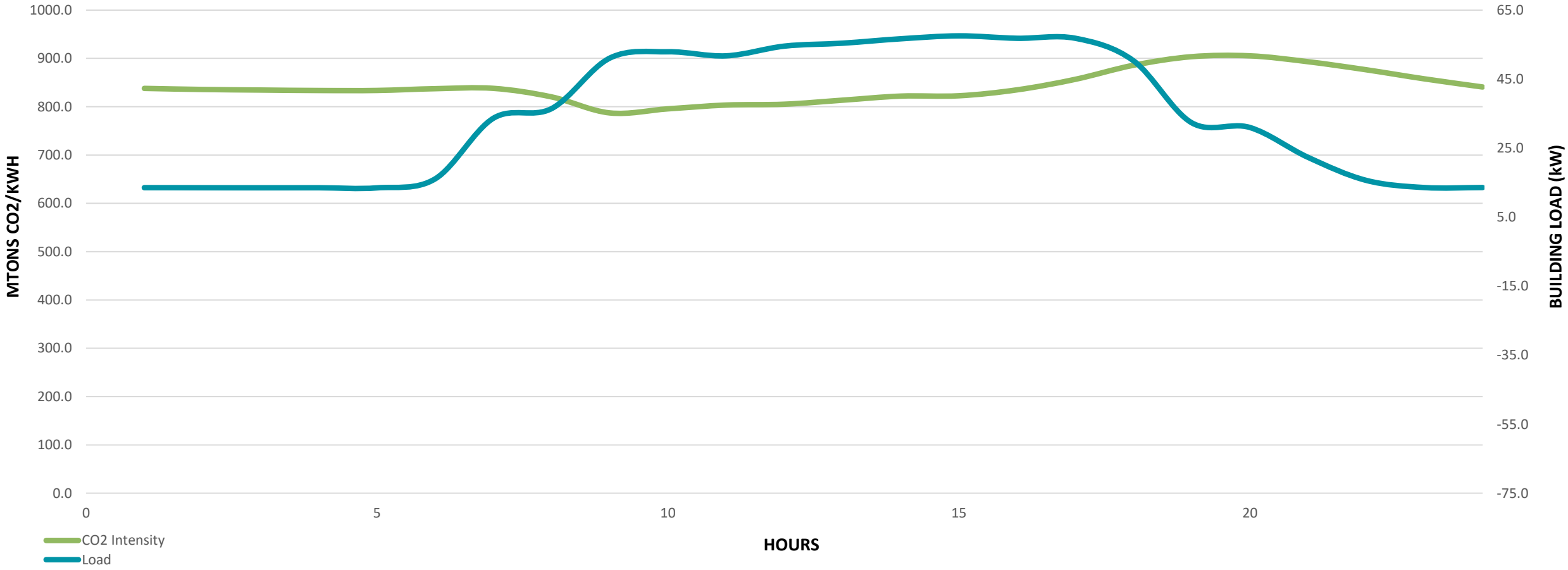
139 Resilient Workdays

$5,000/Day

BATTERY CO2 IMPACT

Emissions from Annual Operation

Energy Efficient office Building,
PacifiCorp West Grid Profile
114 Metric Tons



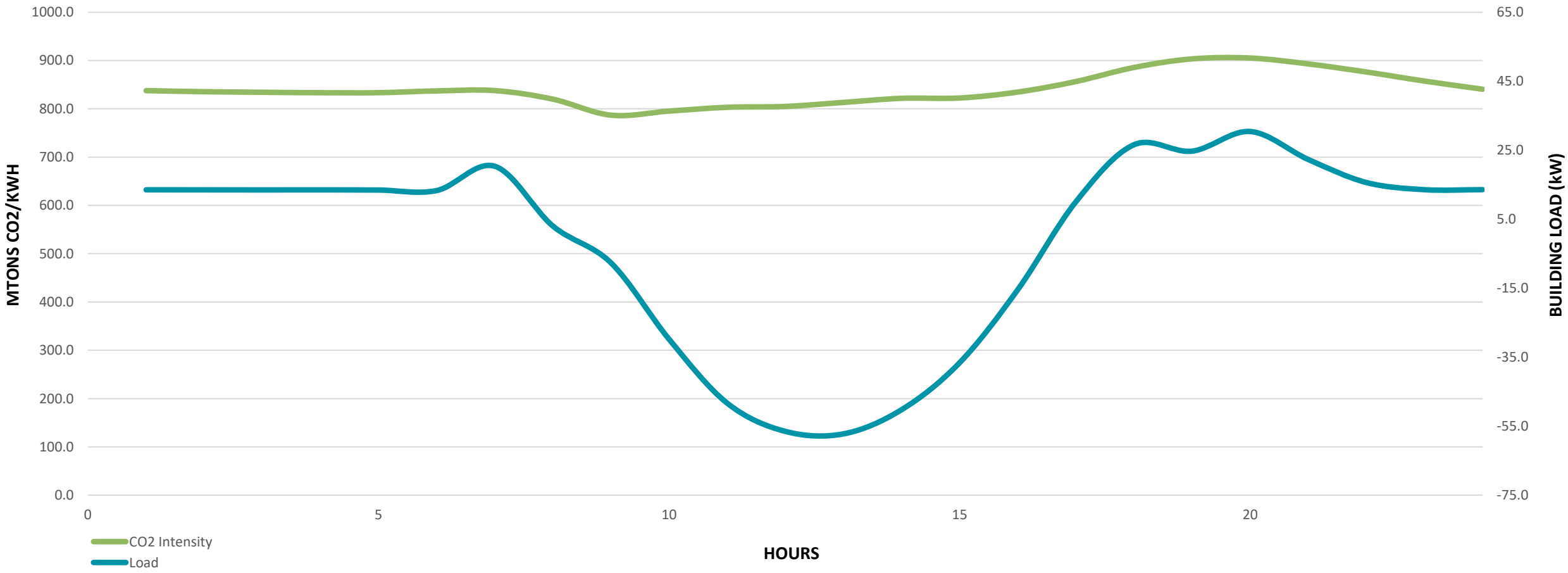
BATTERY CO2 IMPACT

Emissions from Annual Operation

Energy Efficient office Building, PacifiCorp West Grid Profile

NZE solar with 5% buffer: net CO2 benefit annually

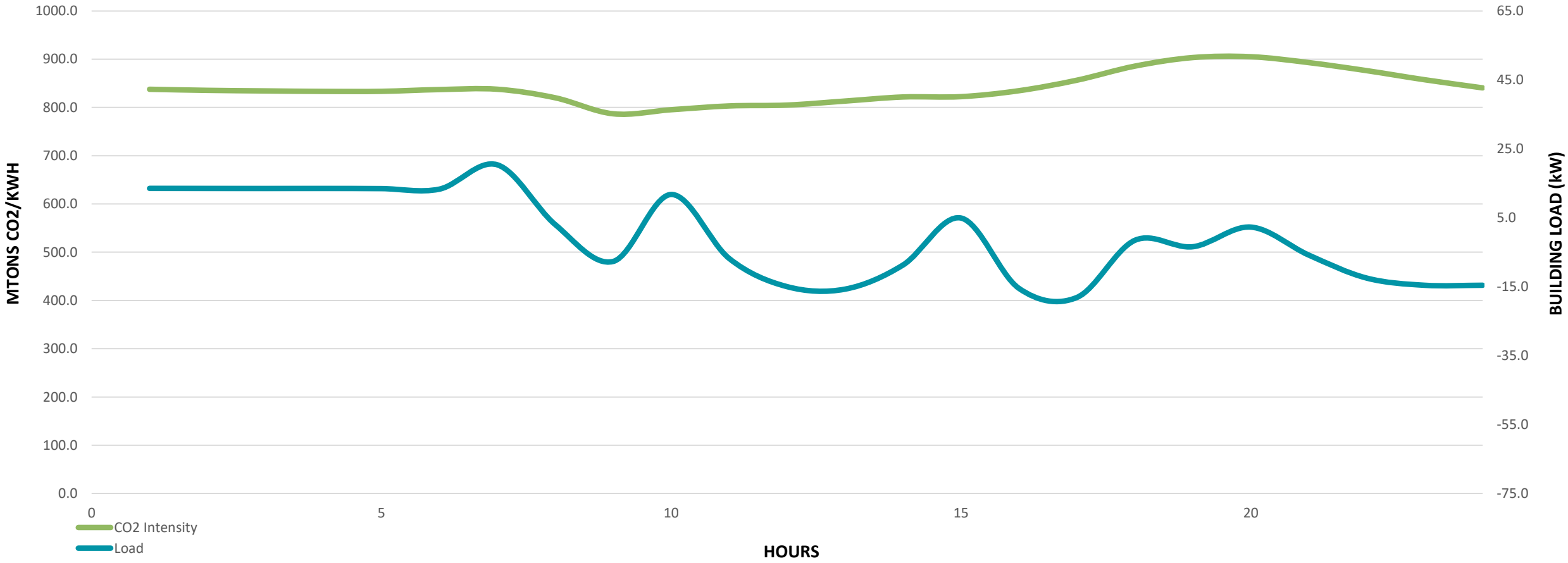
- 5 Metric Tons



BATTERY CO2 IMPACT

Emissions from Annual Operation

Energy Efficient office Building, PacifiCorp West Grid Profile
With 250 kWh battery
-5 Metric Tons



Business Continuity Takeaways

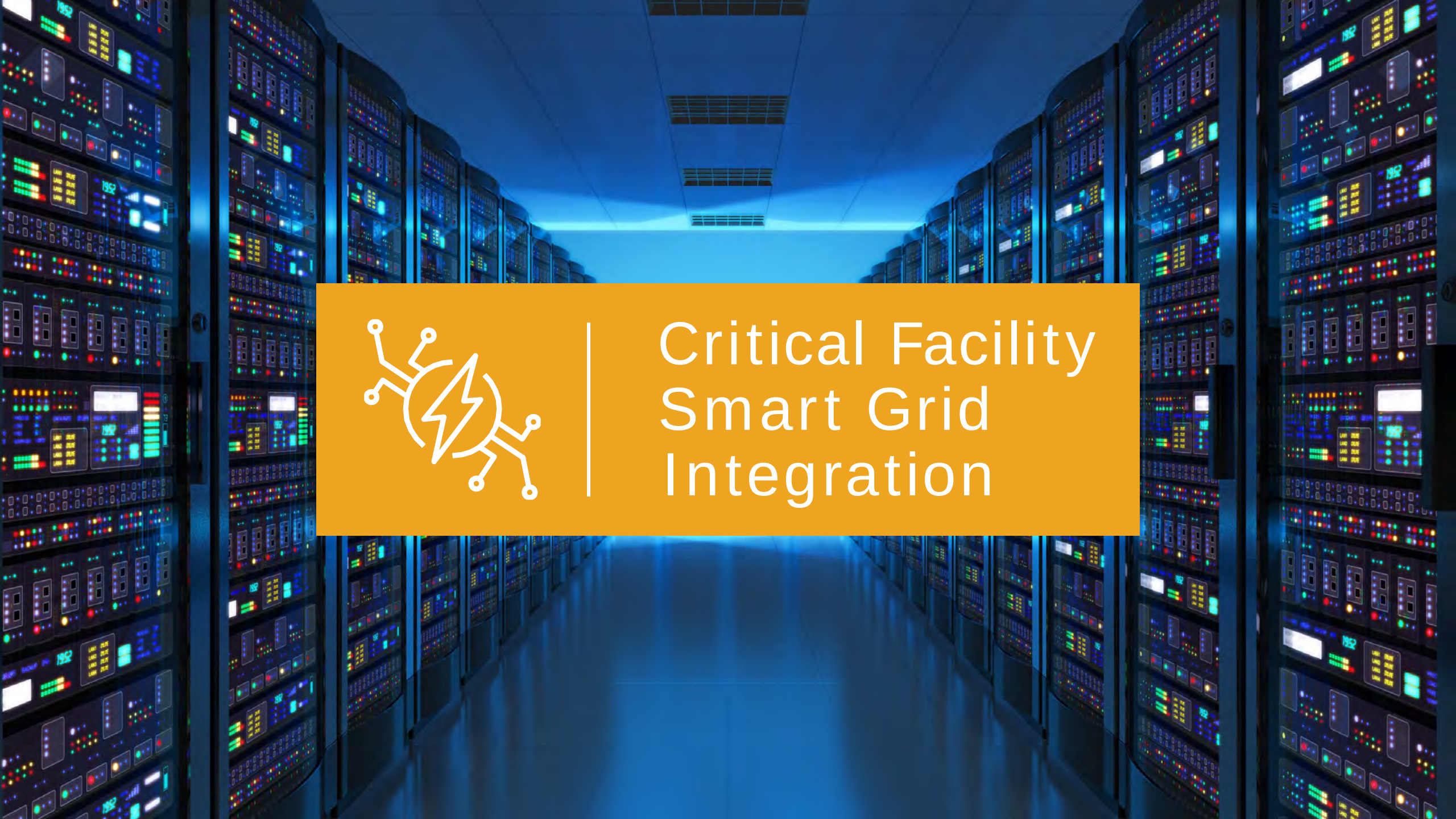
Curtailment is a critical element to broad resiliency. The most impactful curtailment measures are Passive Design features.

NATURAL VENTILATION

LOW LOADS

Acceptable comfort without conditioning

DAYLIGHTING


Critical Facility
Smart Grid
Integration

Critical Facility Energy Profile

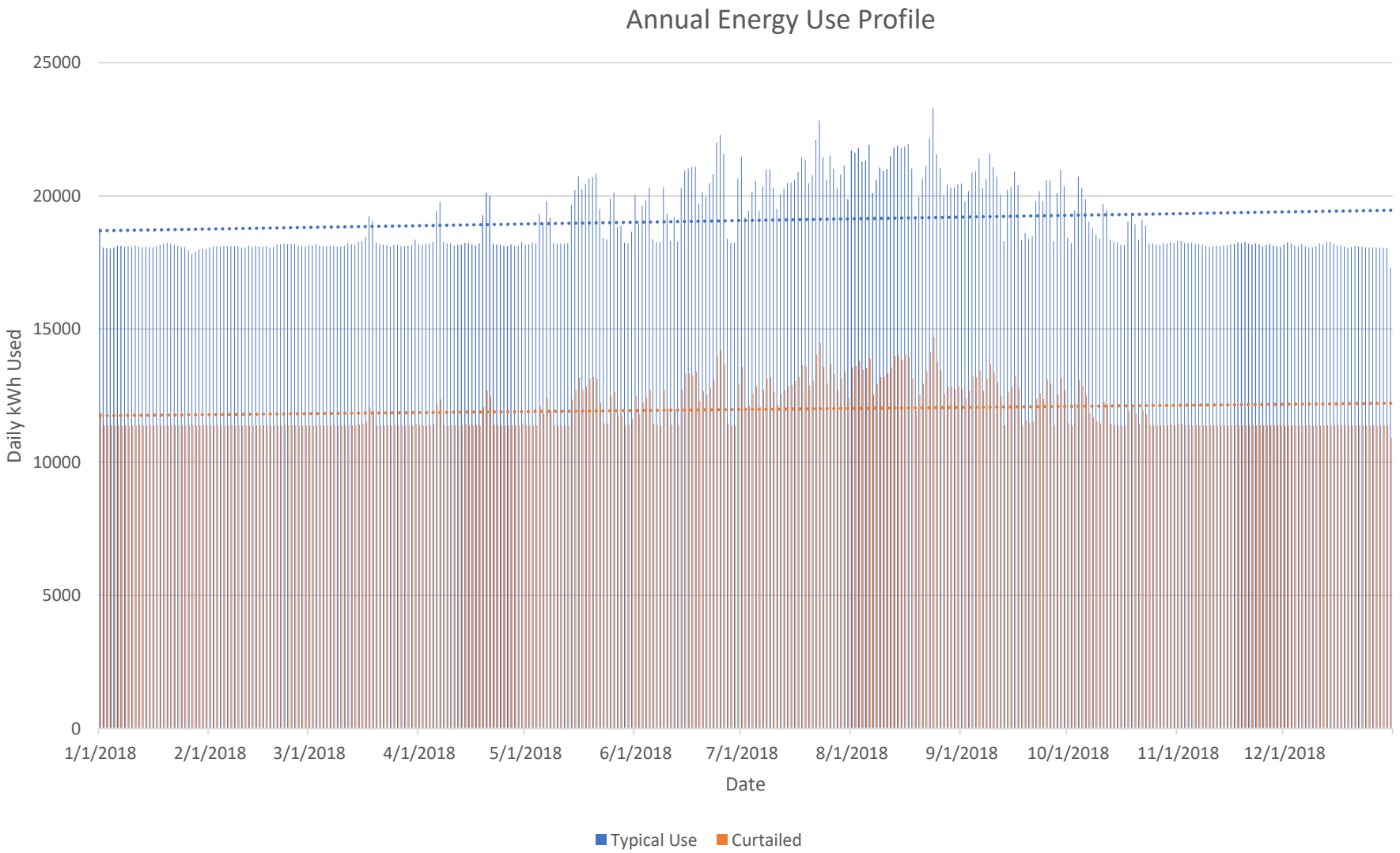
Curtailment Strategies:

IN NON-CRITICAL ZONE

- Lights off
- Temperature set back
- Ventilation off
- Plug loads reduced to laptops only

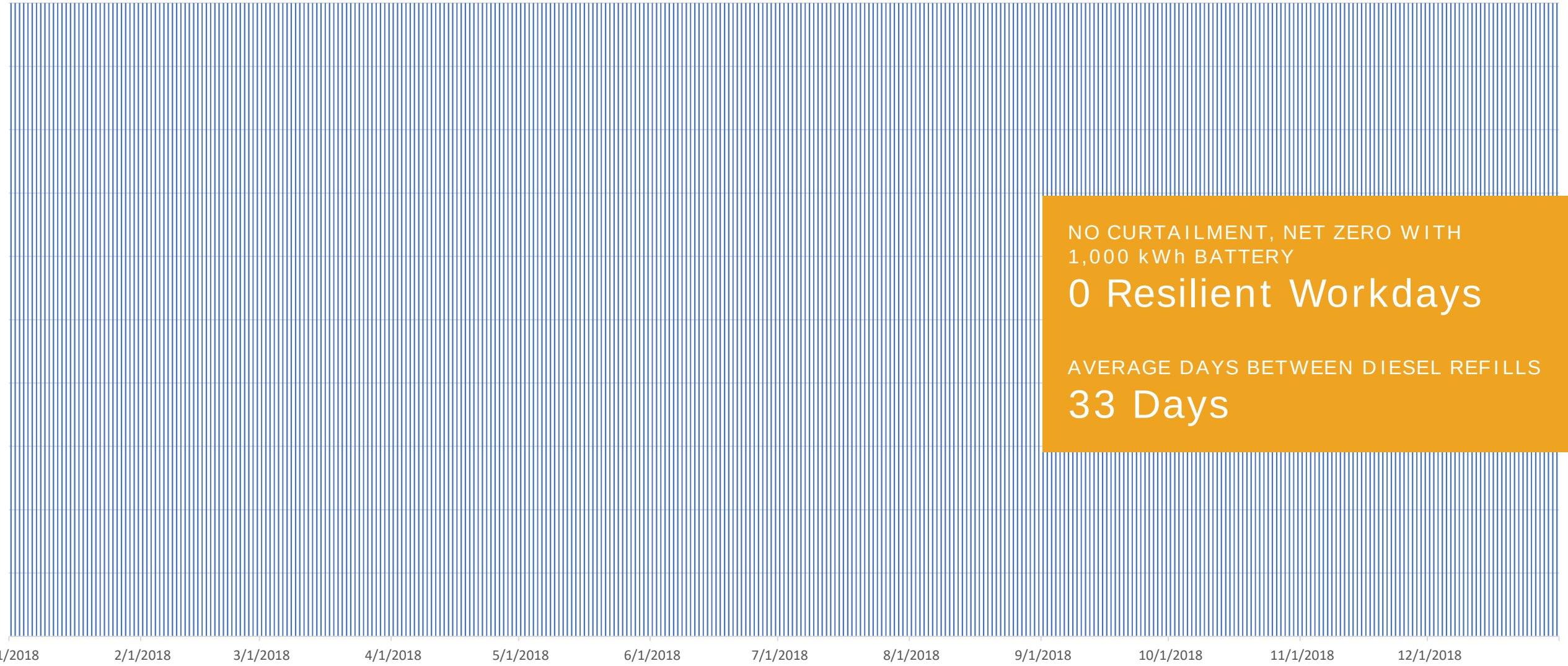
BOTH CRITICAL / NON-CRITICAL

- Elevator not used
- Only cold domestic water



Critical Facility Energy Profile

DAYS AT RISK OF AN EMPTY BATTERY WHEN ISLANDING



NO CURTAILMENT, NET ZERO WITH 1,000 kWh BATTERY

0 Resilient Workdays

AVERAGE DAYS BETWEEN DIESEL REFILLS

33 Days

Critical Facility Energy Profile

DAYS AT RISK OF AN EMPTY BATTERY WHEN ISLANDING

INCREASE BATTERY TO 6,000 kWh

89 Resilient Workdays

$47,000/Day

AVERAGE DAYS BETWEEN DIESEL REFILLS

183 Days

Critical Facility Energy Profile

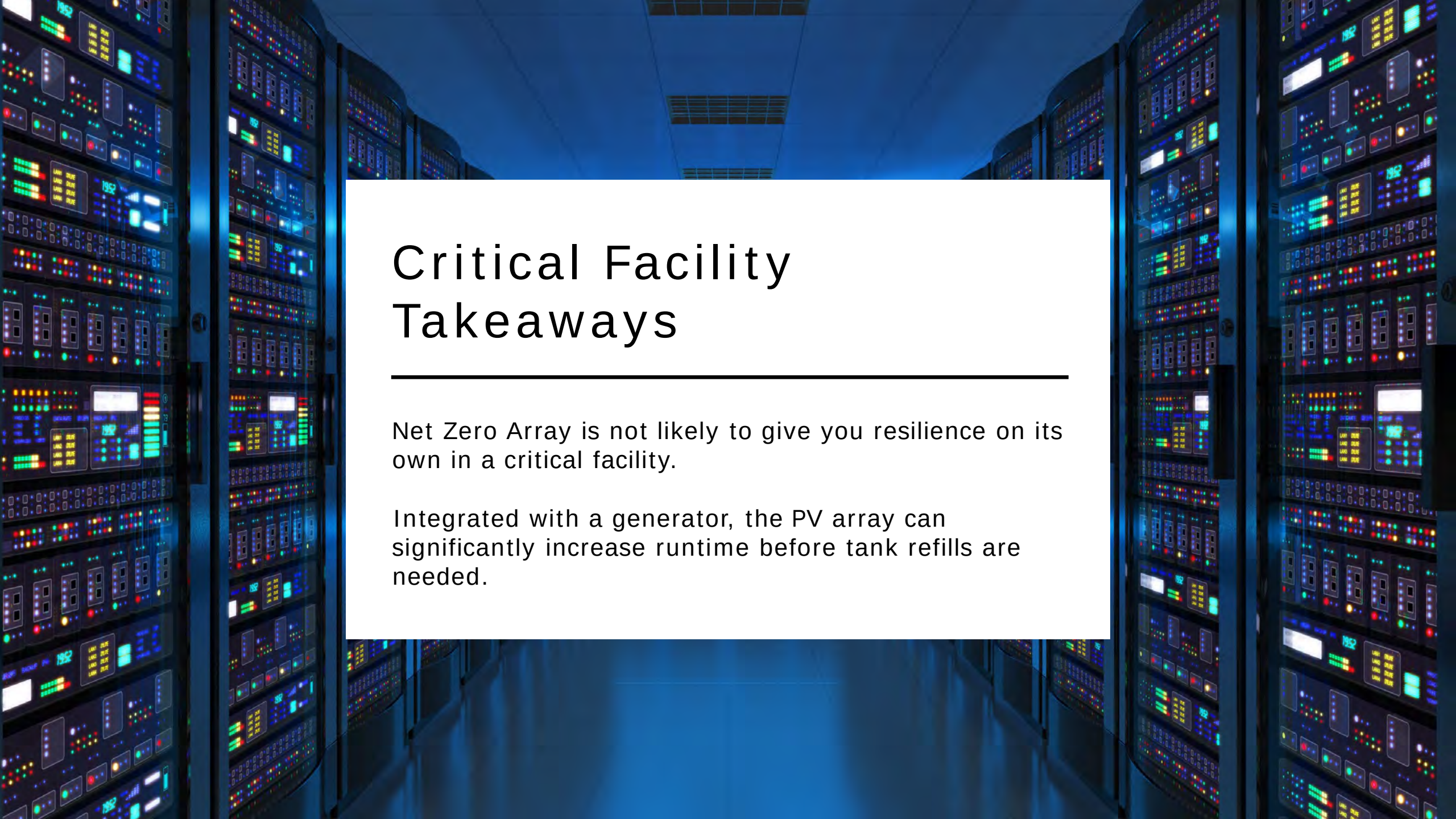
DAYS AT RISK OF AN EMPTY BATTERY WHEN ISLANDING

INCREASE BATTERY TO ONE FULL DAY:
20,000 kWh

365 Resilient Workdays
$73,000/Day

AVERAGE DAYS BETWEEN DIESEL REFILLS

365 Days



Critical Facility Takeaways

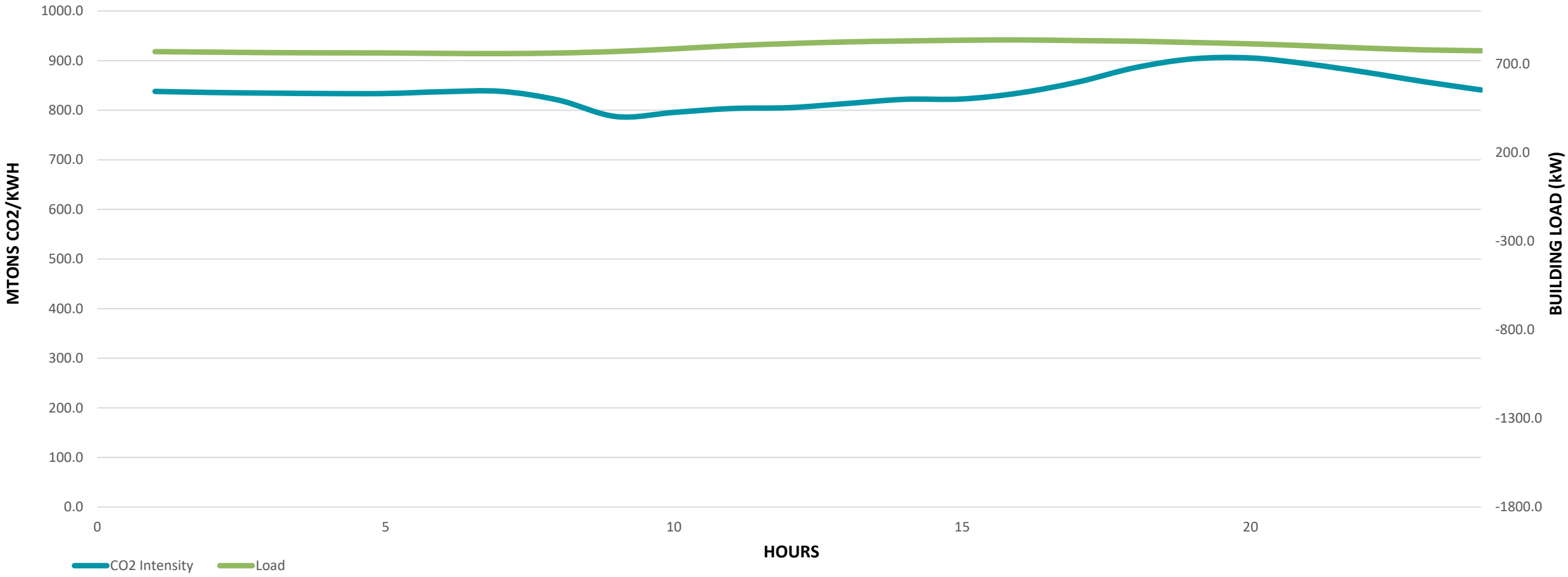
Net Zero Array is not likely to give you resilience on its own in a critical facility.

Integrated with a generator, the PV array can significantly increase runtime before tank refills are needed.

BATTERY CO2 IMPACT

Emissions from Annual Operation

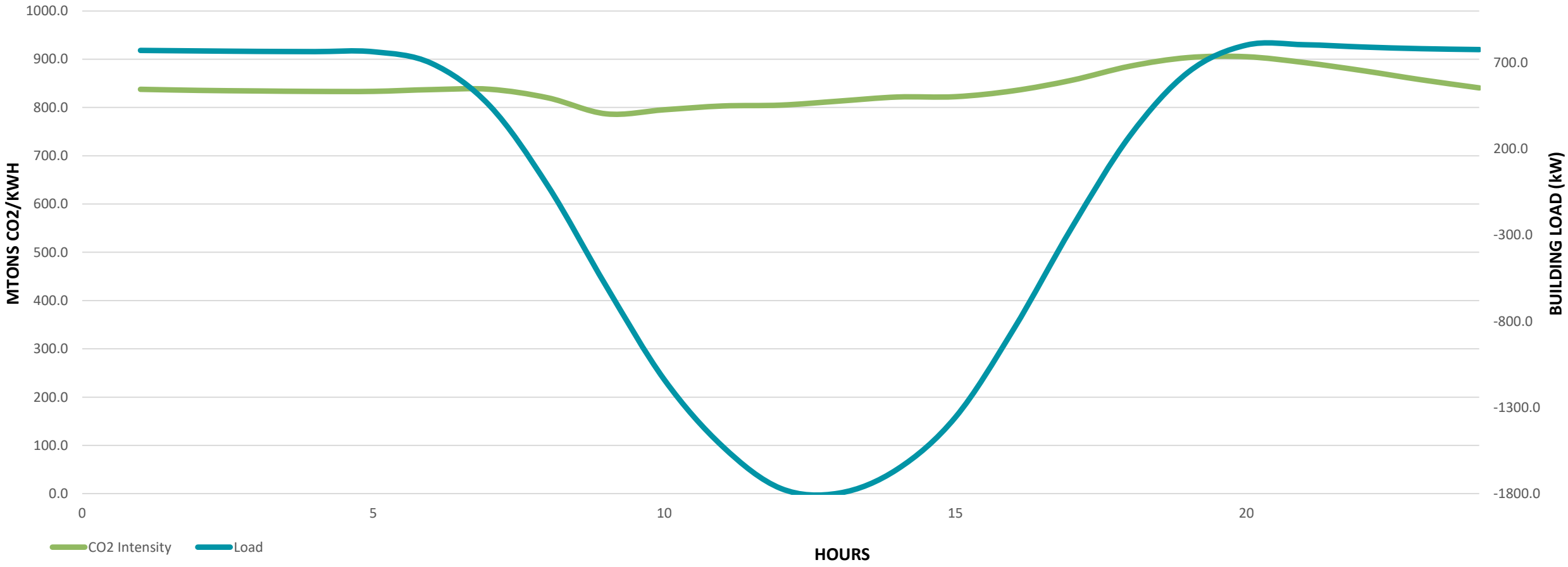
Critical Data Center, PacifiCorp West Grid Profile
2700 Metric Tons



BATTERY CO2 IMPACT

Emissions from Annual Operation

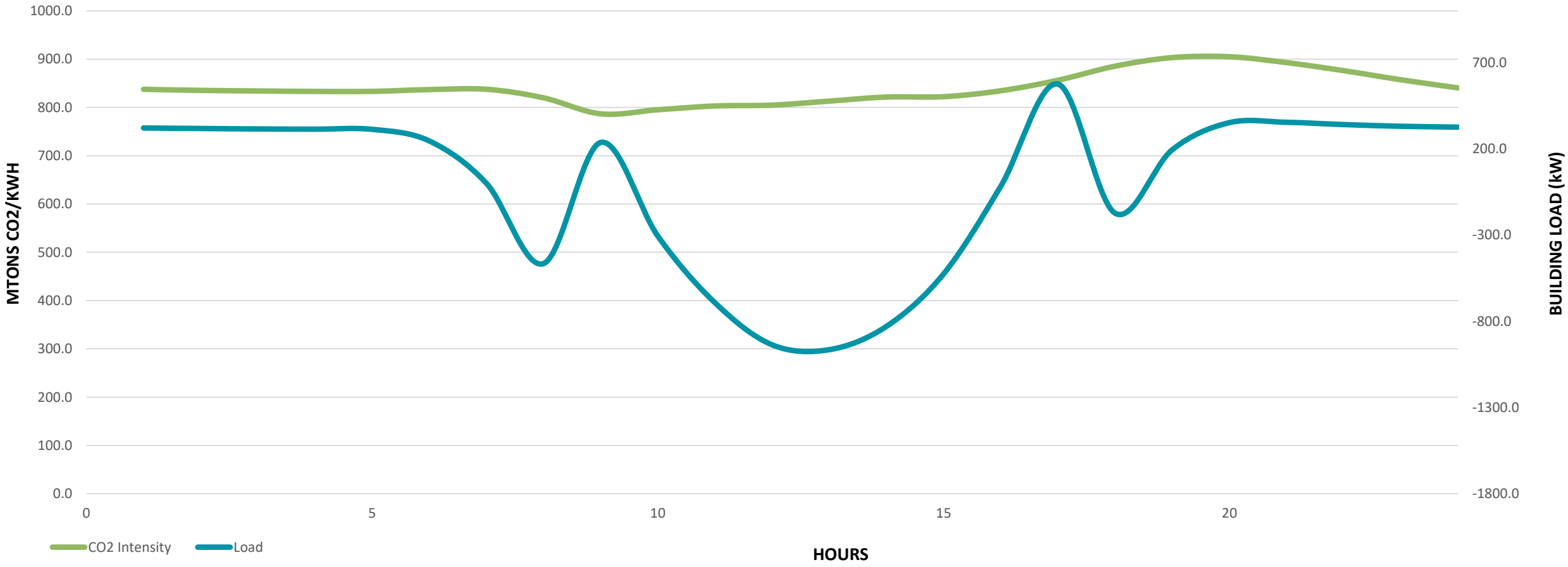
Critical Data Center, PacifiCorp West Grid Profile
-110 Metric Tons

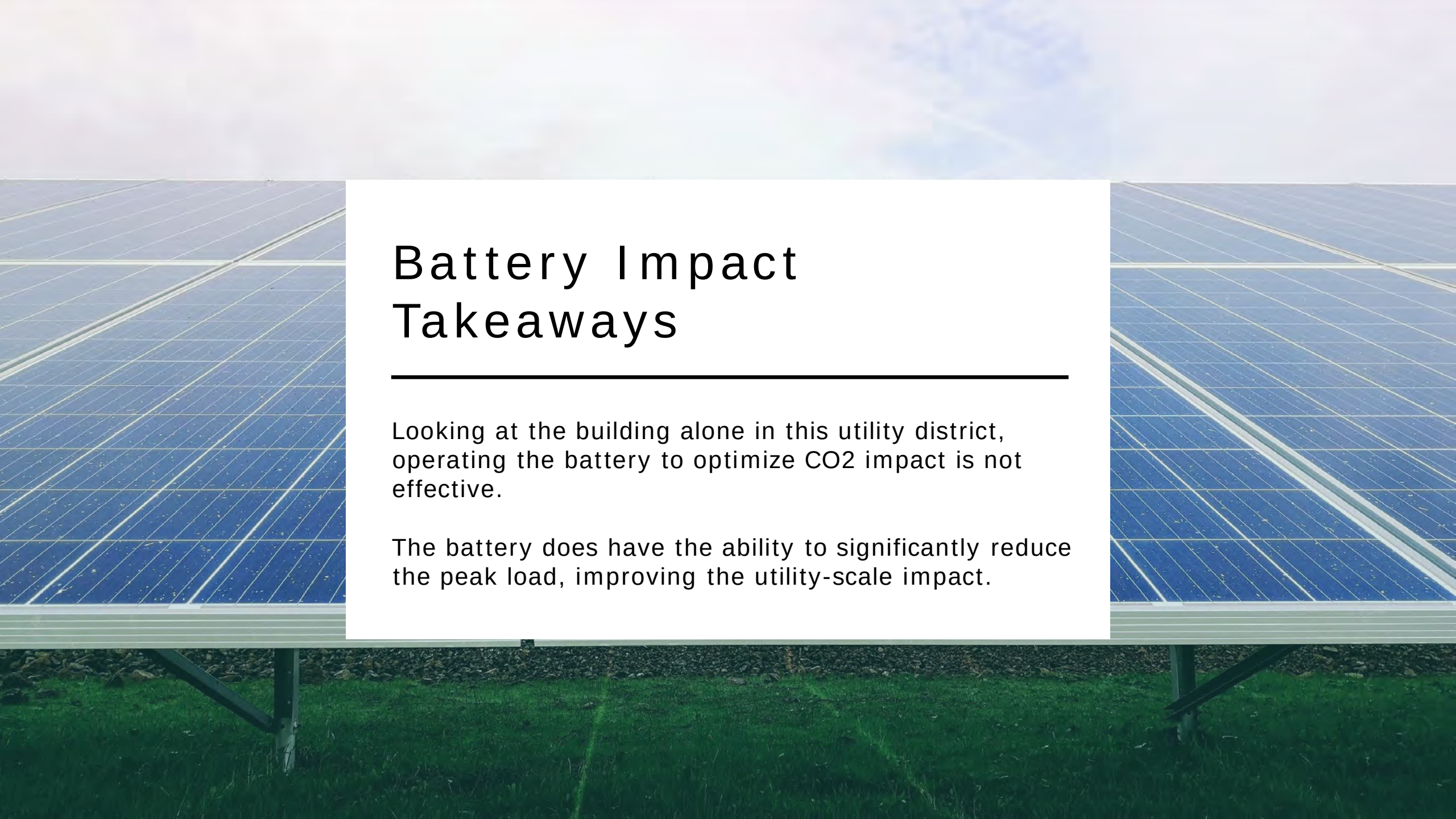


BATTERY CO2 IMPACT

Emissions from Annual Operation

Critical Data Center, PacifiCorp West Grid Profile
7,500 kWh Battery
-53 Metric Tons





Battery Impact Takeaways

Looking at the building alone in this utility district, operating the battery to optimize CO2 impact is not effective.

The battery does have the ability to significantly reduce the peak load, improving the utility-scale impact.

Acknowledgments

Marc Brune | PAE Engineers
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Questions?