



# Thermal Energy Storage:

Creating new opportunities

IDEA Webinar  
September 11, 2018







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- ☐ The webinar will **start promptly at 1:00pm EDT (Boston time) and is scheduled to last sixty (60) minutes; including time for questions.**
- ☐ Please **mute your phone** during the webinar. All lines are muted.
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# Upcoming IDEA Conferences







**Owen Smith**

Director of Utility & Grid Solutions, Trane



**Paul Valenta**

VP of Sales & Marketing, CALMAC Portfolio, Trane



**Joe Riemer**

Product Support and Customer Services Leader-  
Centrifugal Water-Cooled Chillers, Trane



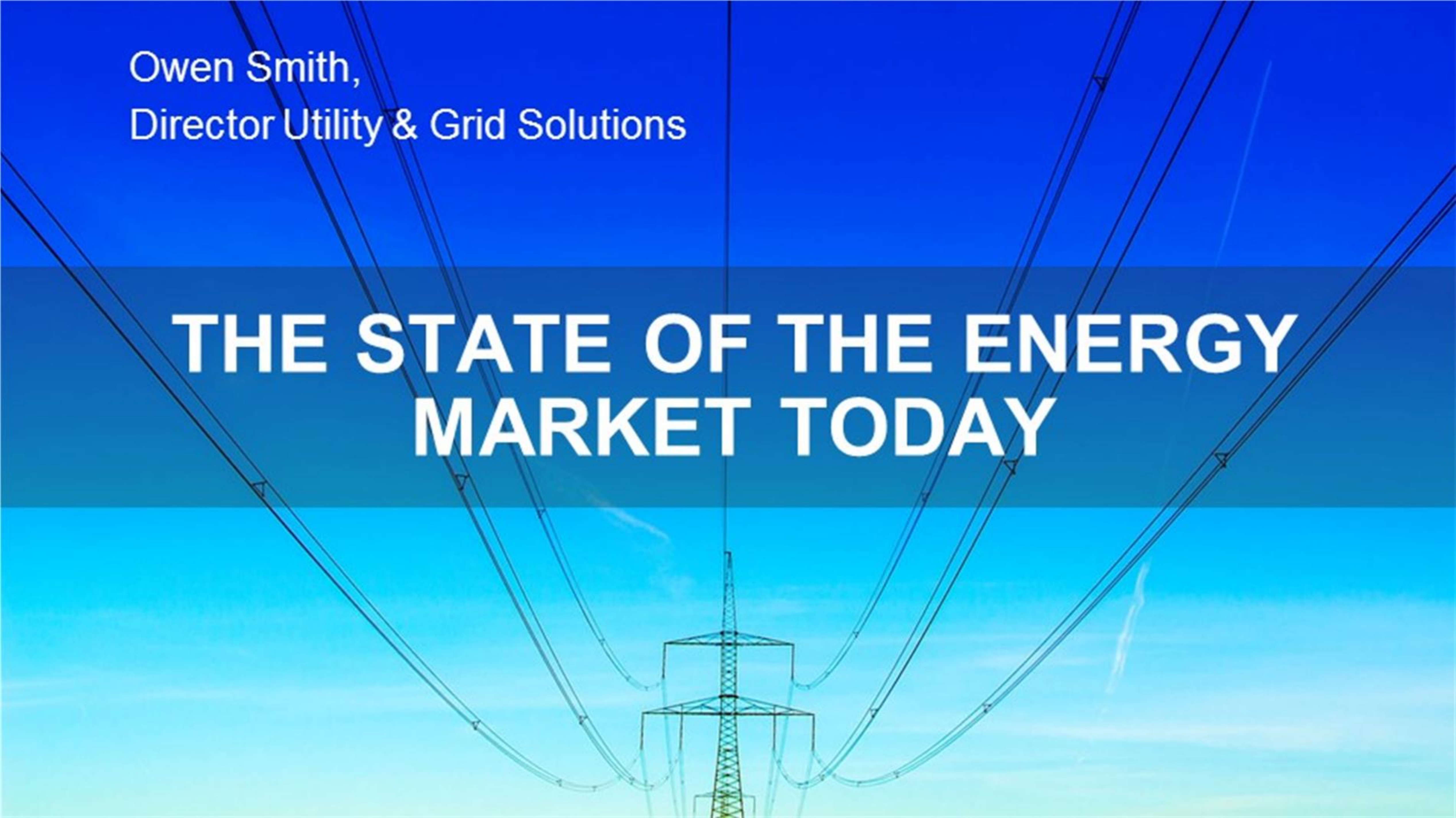
**Laxmi Rao - Moderator**

Director, International District Energy Association



Owen Smith,  
Director Utility & Grid Solutions

# THE STATE OF THE ENERGY MARKET TODAY





# World of Energy



**Corporate Sustainability**



**Regulations and Policy**



**New Technologies  
and Capabilities**



**Utility Industry  
Transformation**

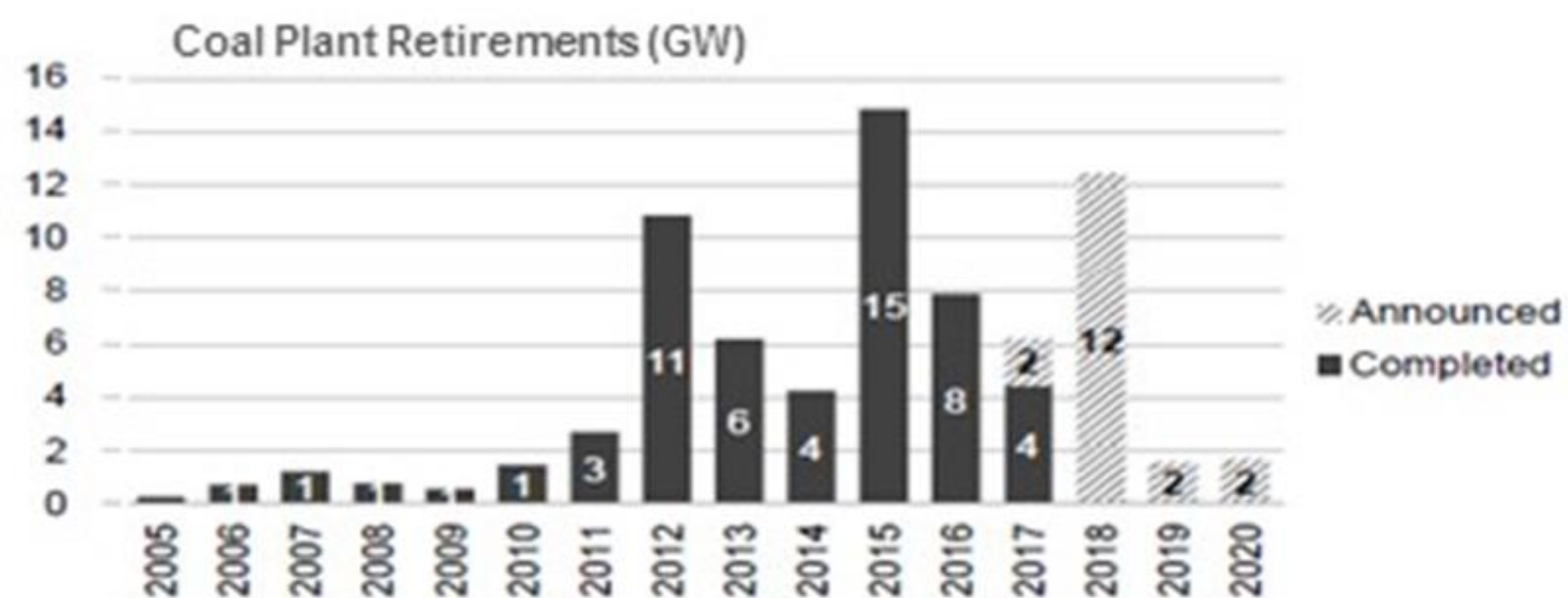


**Building Energy  
Management**

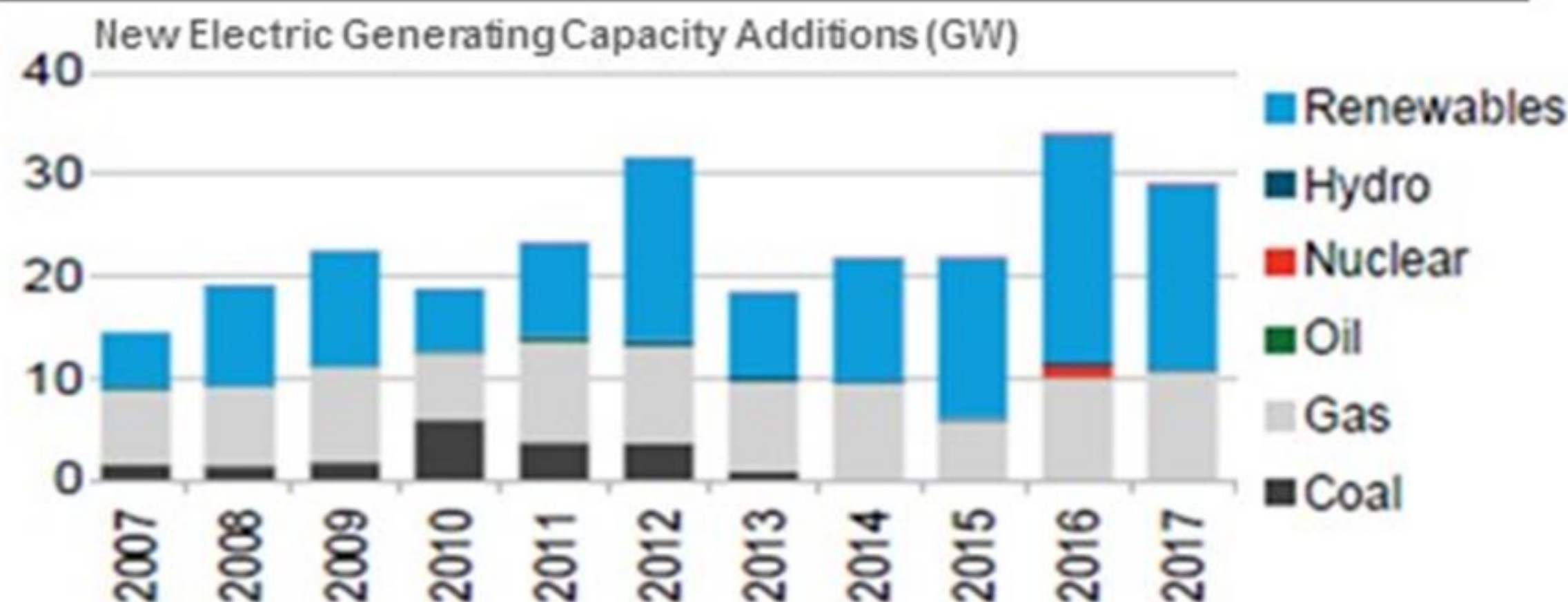


# Utility Industry Facing Transformation

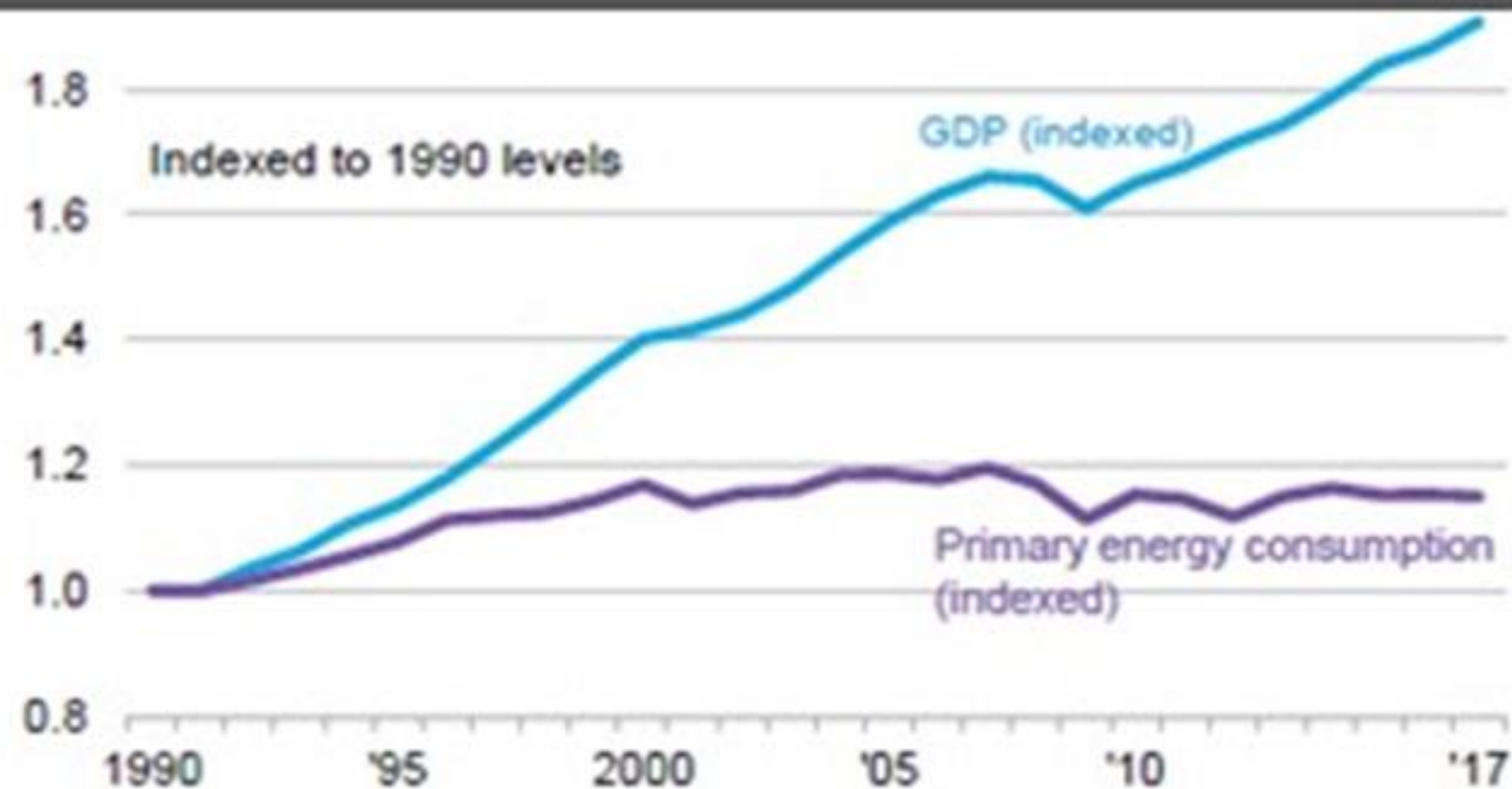
Aging infrastructure – wires & power plants – driving capital investments & rate increases



Growth of non-dispatchable generation (solar & wind) driving value of load flexibility



Flat energy sales – but increasing peak loads – increases value of ability to shape & shift energy use



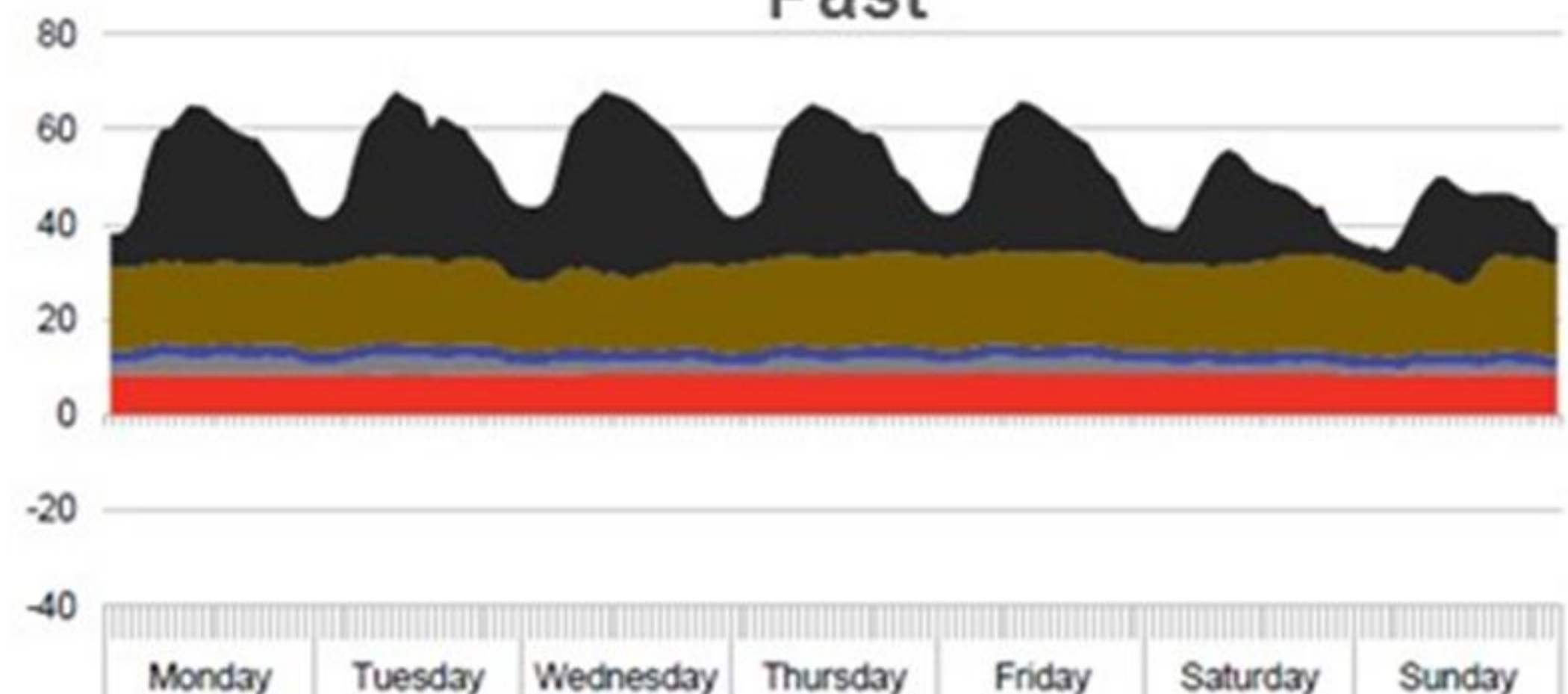
Growing Capital Expenditures by U.S. Utilities





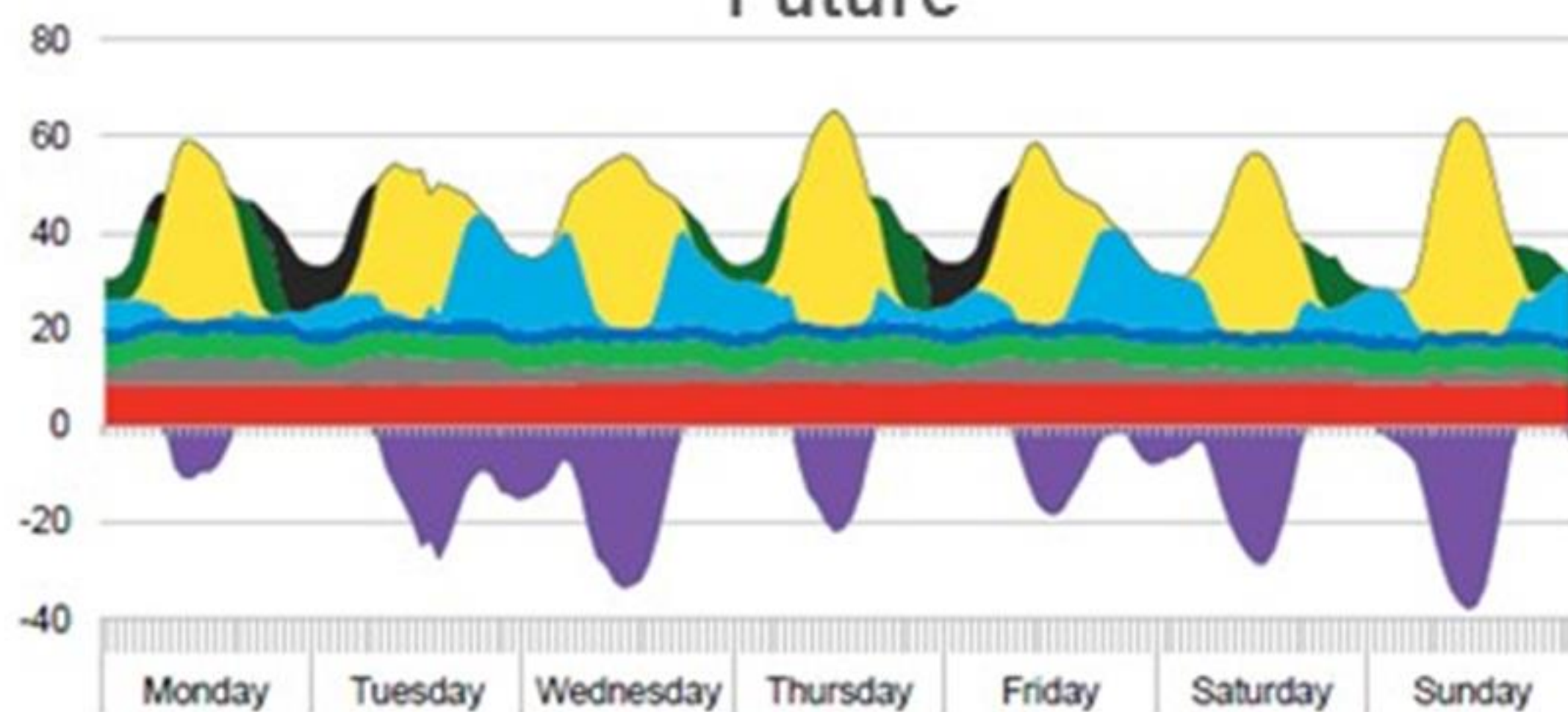
# Evolving Structure of Power Supply

Past



- ▶ Past: Demand met with centralized Controllable Resources – “Dispatchable”

Future



- ▶ Future: Demand met with:
  - ▶ Variable Resources – “Non-Dispatchable”
  - PLUS
  - ▶ Load Flexibility Solutions

■ Peaking fossil ■ Baseload fossil ■ Nuclear  
■ CHP ■ Hydro ■ Baseload RE ■ Solar  
■ Wind ■ Pumped hydro generation/Storage  
■ Imports ■ Exports/curtailment/DR

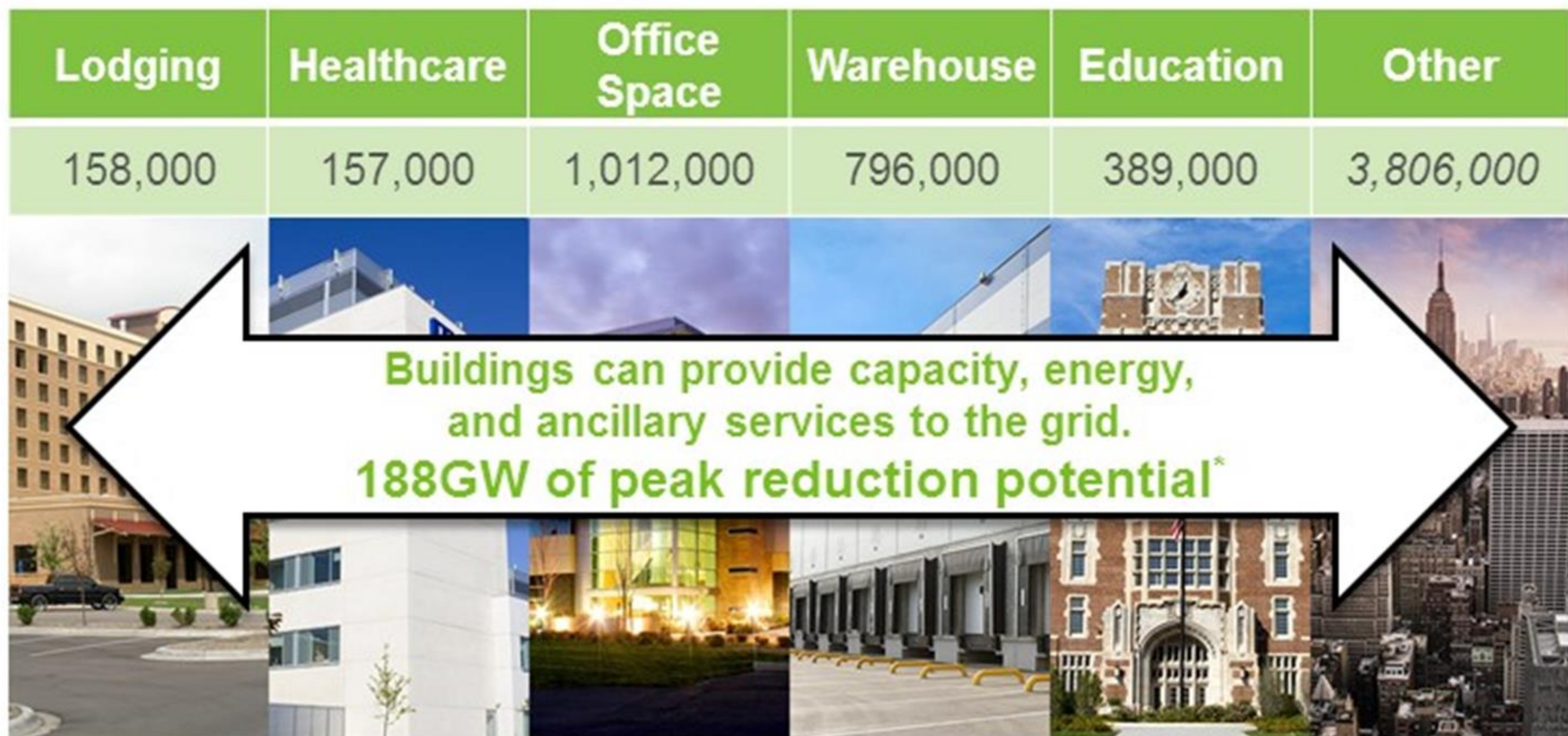
***Load Flexibility Becoming Increasingly Important***



# Buildings and Industrial Sites Can Help...

## Leveraging *Buildings as a Resource*<sup>™</sup> (BaaR<sup>™</sup>) for the Grid

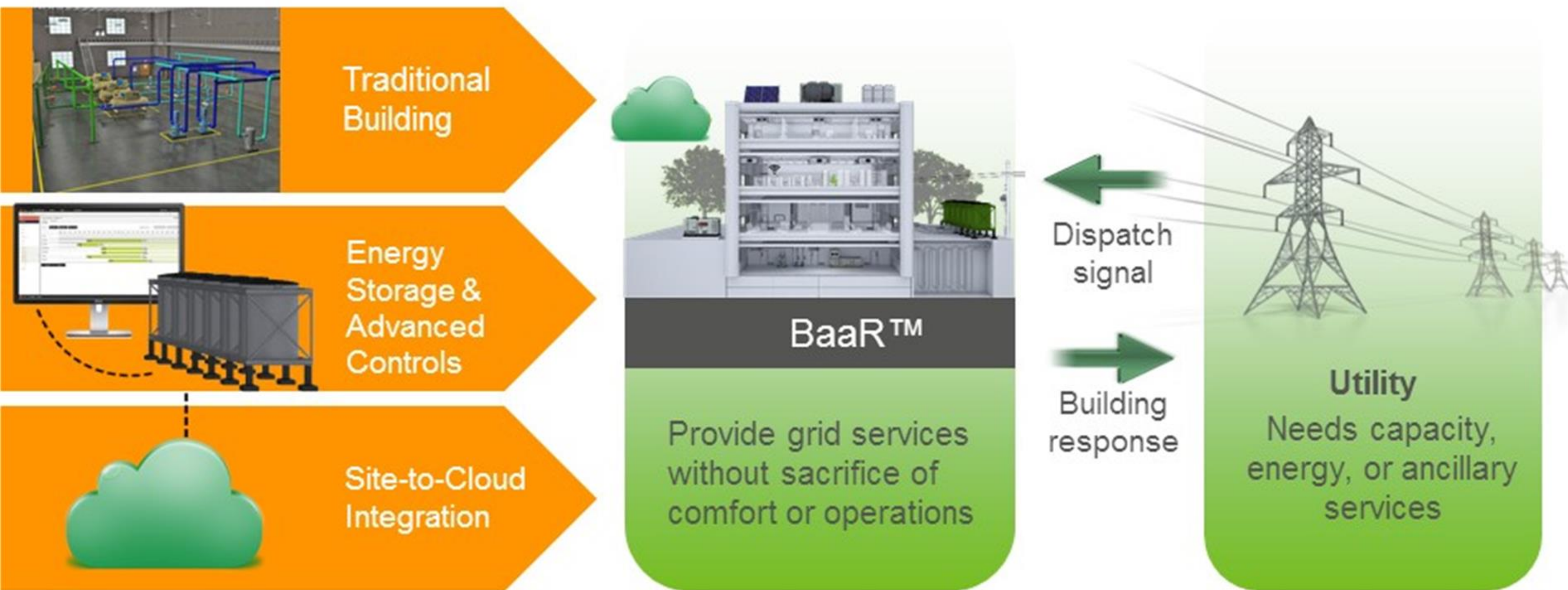
Over 5 million buildings across the United States



Source: FERC, GAO-14-73 Electricity Markets



# Enabling Buildings as a Resource™






# Thermal Energy Storage Value

According to Western Cooling Efficiency Center at University of California-Davis, the traditional 10 day average methodology for measuring the impact of demand management technologies **underrepresents the value of thermal storage by as much as**

**77%**



Because it does not adequately account for shifts in building loads due to extreme weather, holidays, or weekends.



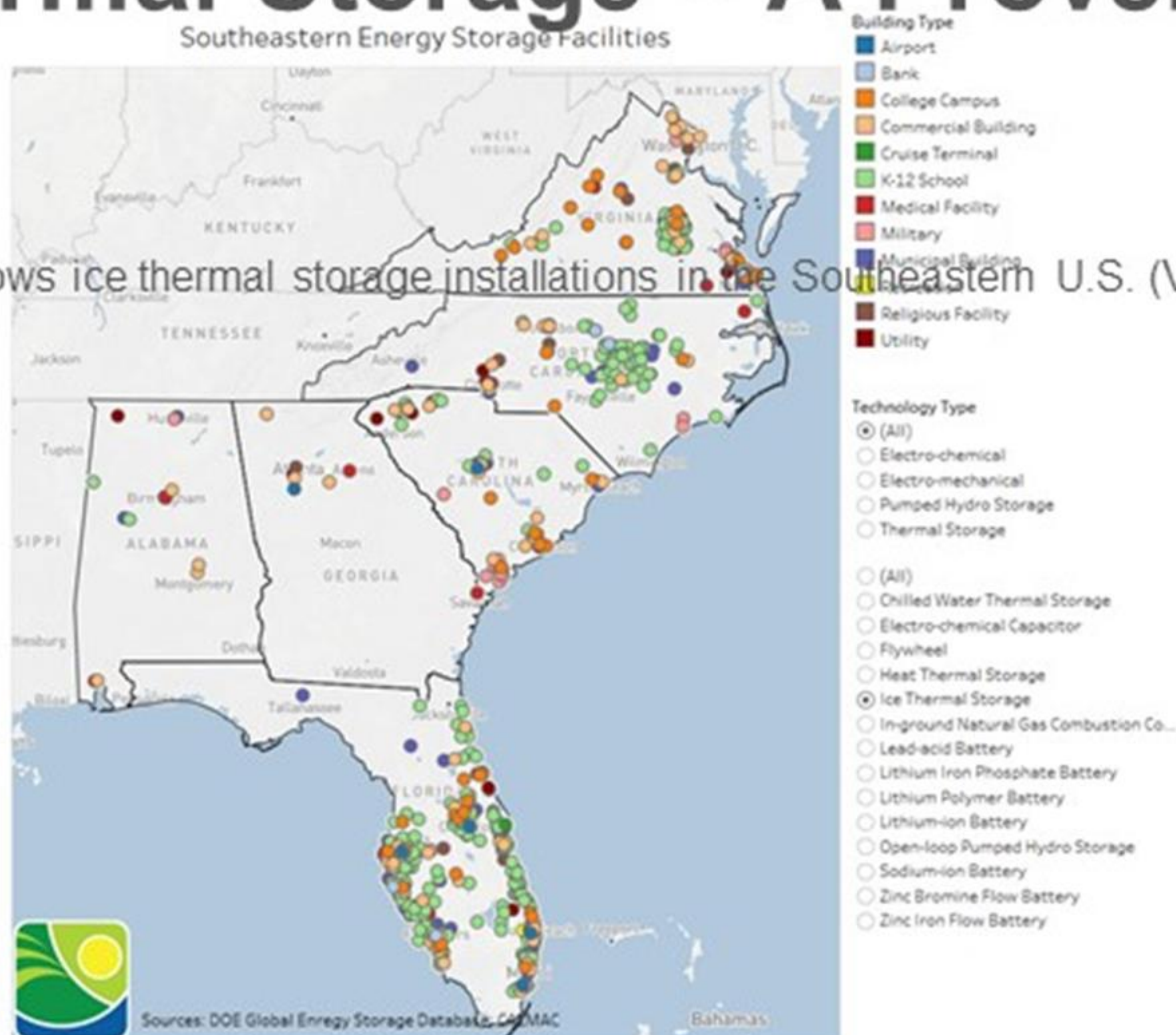
“The value of Thermal Energy Storage systems **are more accurately quantified** when based on **1-IN-10** heat event (hottest hour in 10 years) method - which is how many other utility investments are evaluated”



# Ice Thermal Storage – A Proven Resource

Southeastern Energy Storage Facilities

- Map shows ice thermal storage installations in the Southeastern U.S. (Virginia, NC, SC, Georgia, Alabama, Florida)

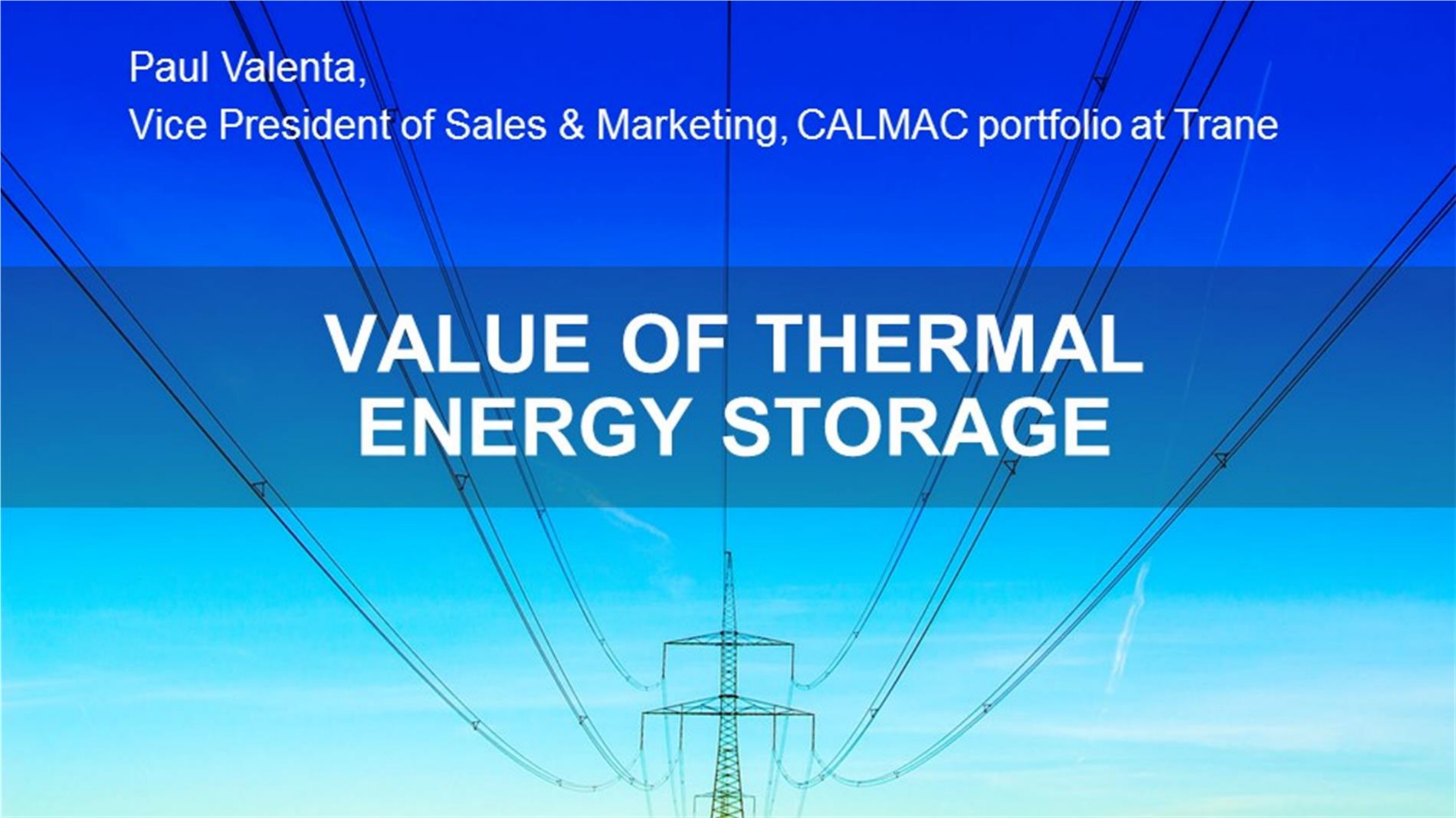


**Thermal Energy Storage Alleviates Strain on the Grid and Delivers Customer Savings**



Paul Valenta,  
Vice President of Sales & Marketing, CALMAC portfolio at Trane

# VALUE OF THERMAL ENERGY STORAGE





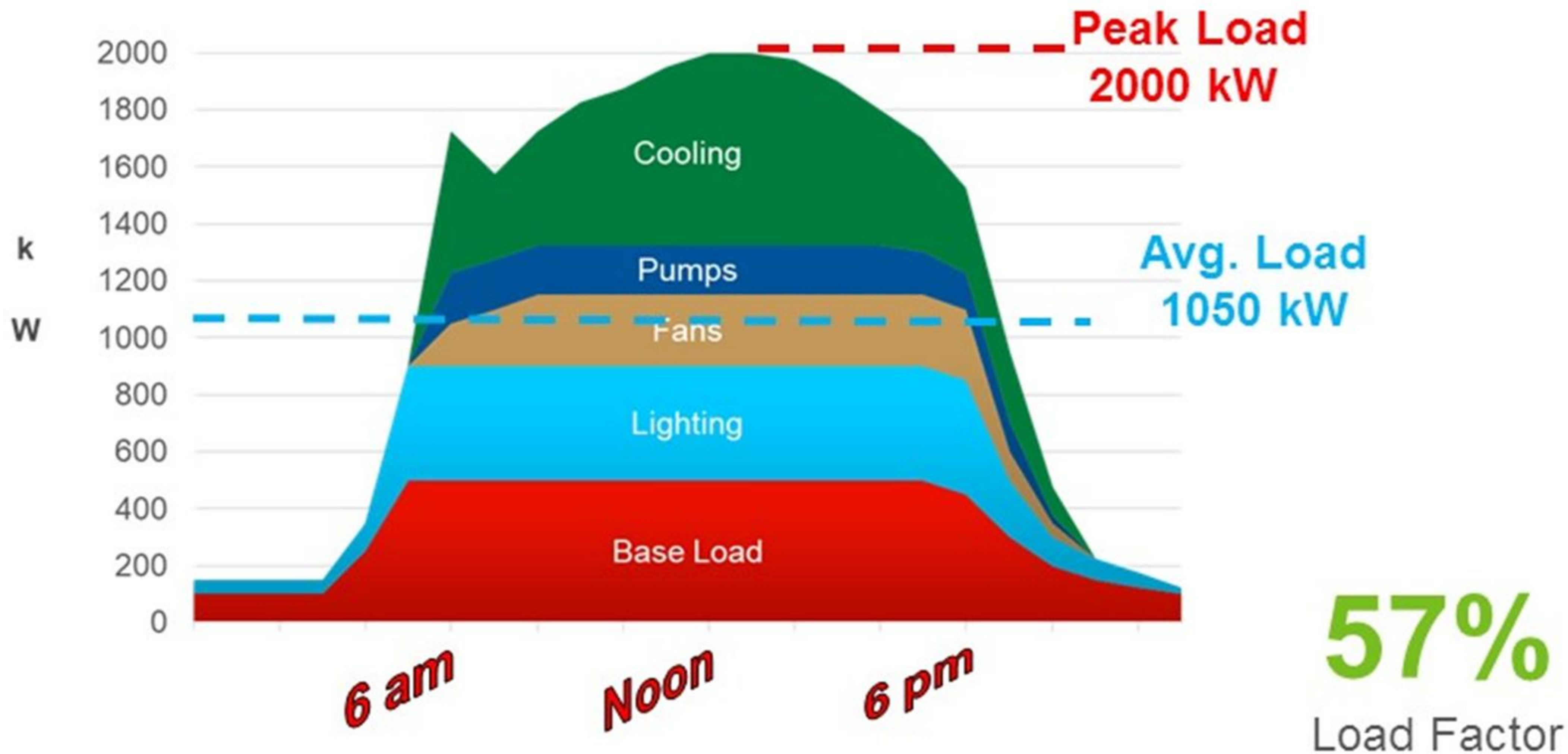
# What Can Thermal Energy Storage Do For You?





# ASHRAE® 90.1 Base Building

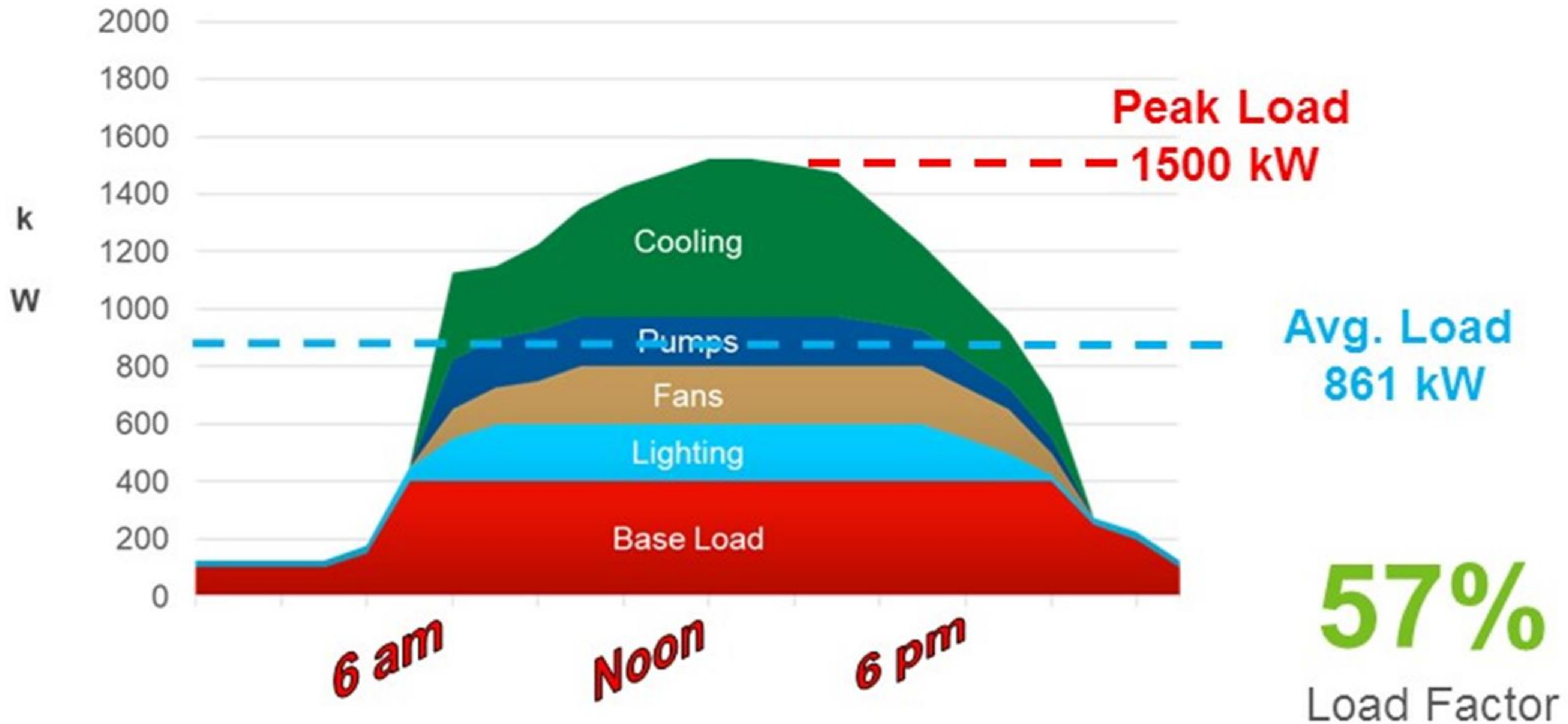
## Non-Storage Electrical Profile





# 30% Better than ASHRAE 90.1 Base Building

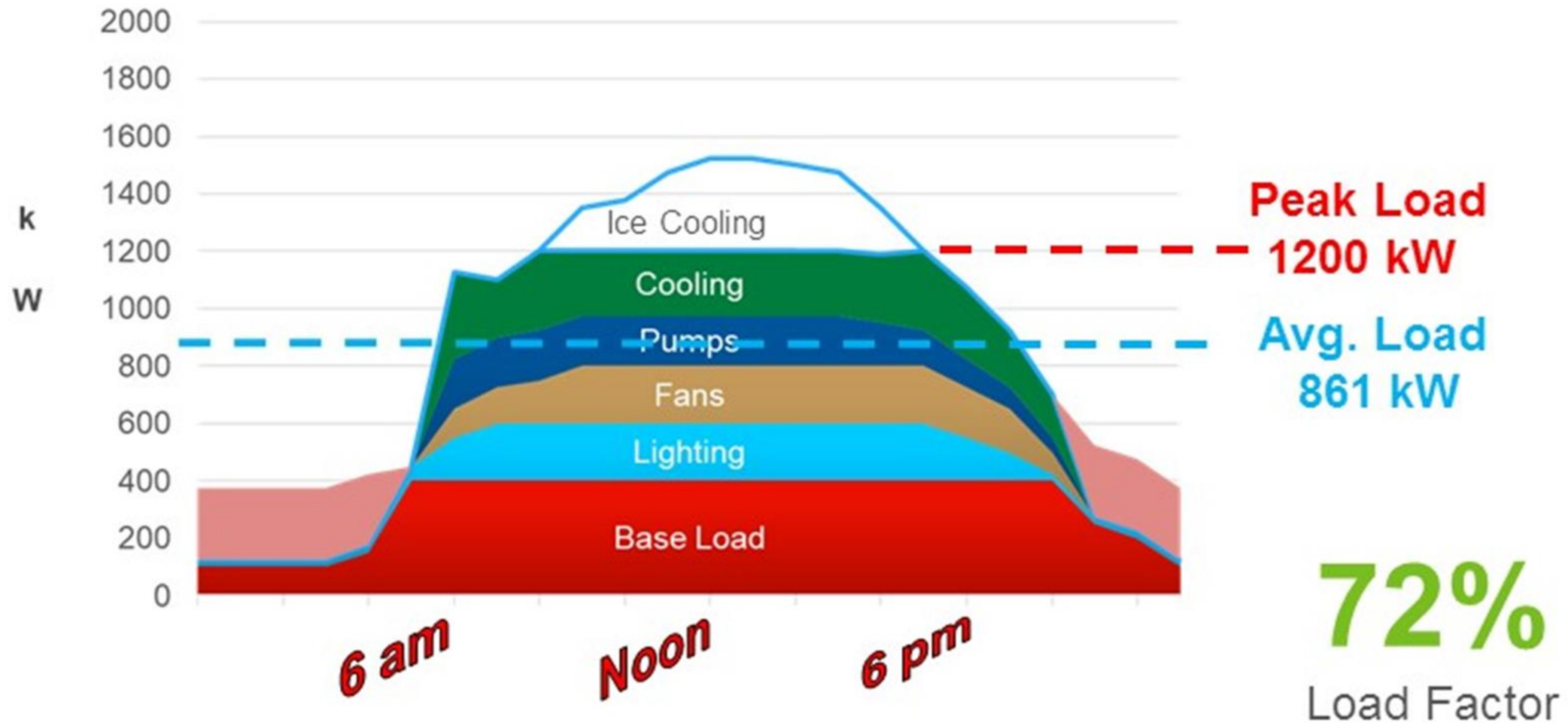
## Non-Storage Electrical Profile





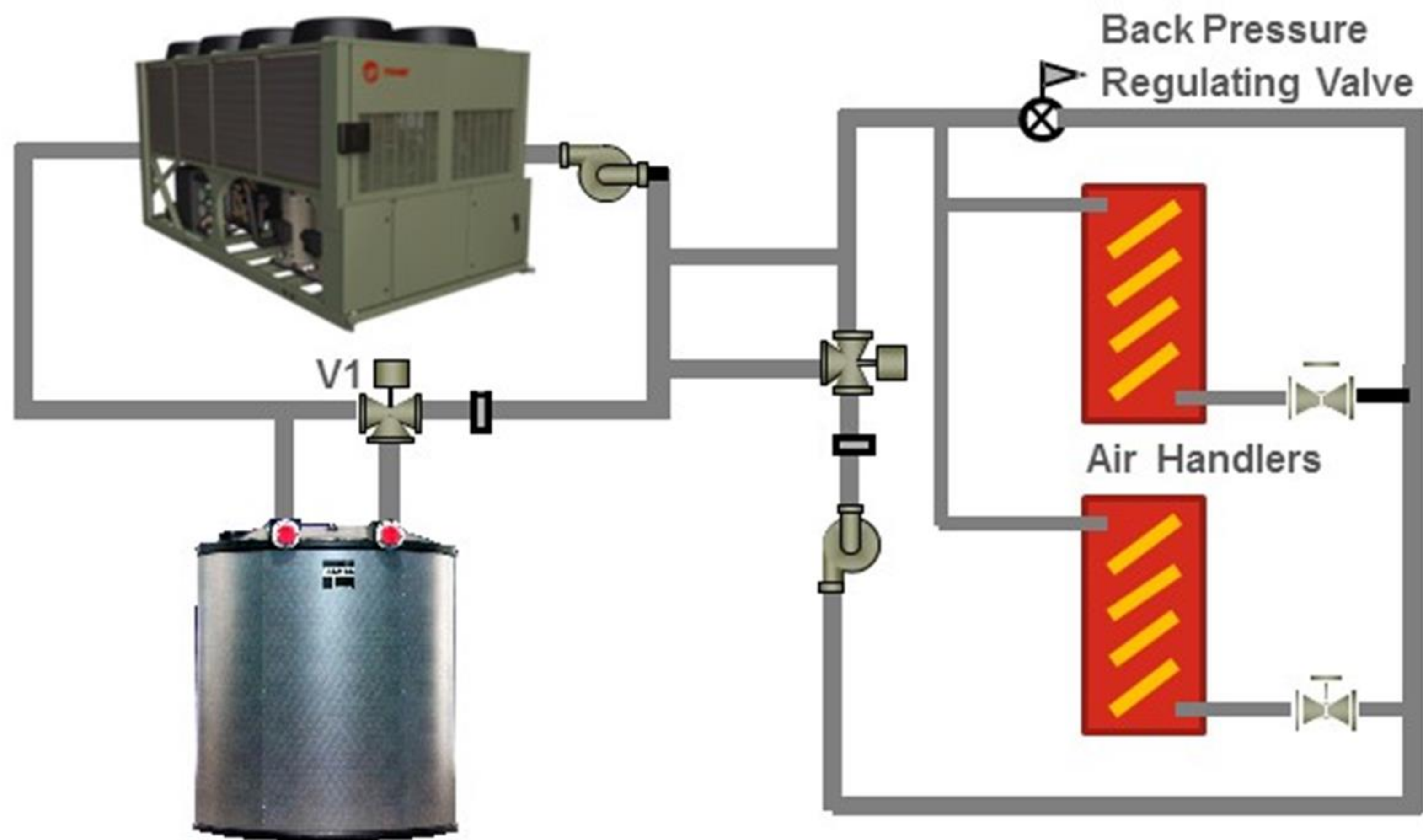
# 30% Better than ASHRAE 90.1 Base Building

## Partial Storage Electrical Profile



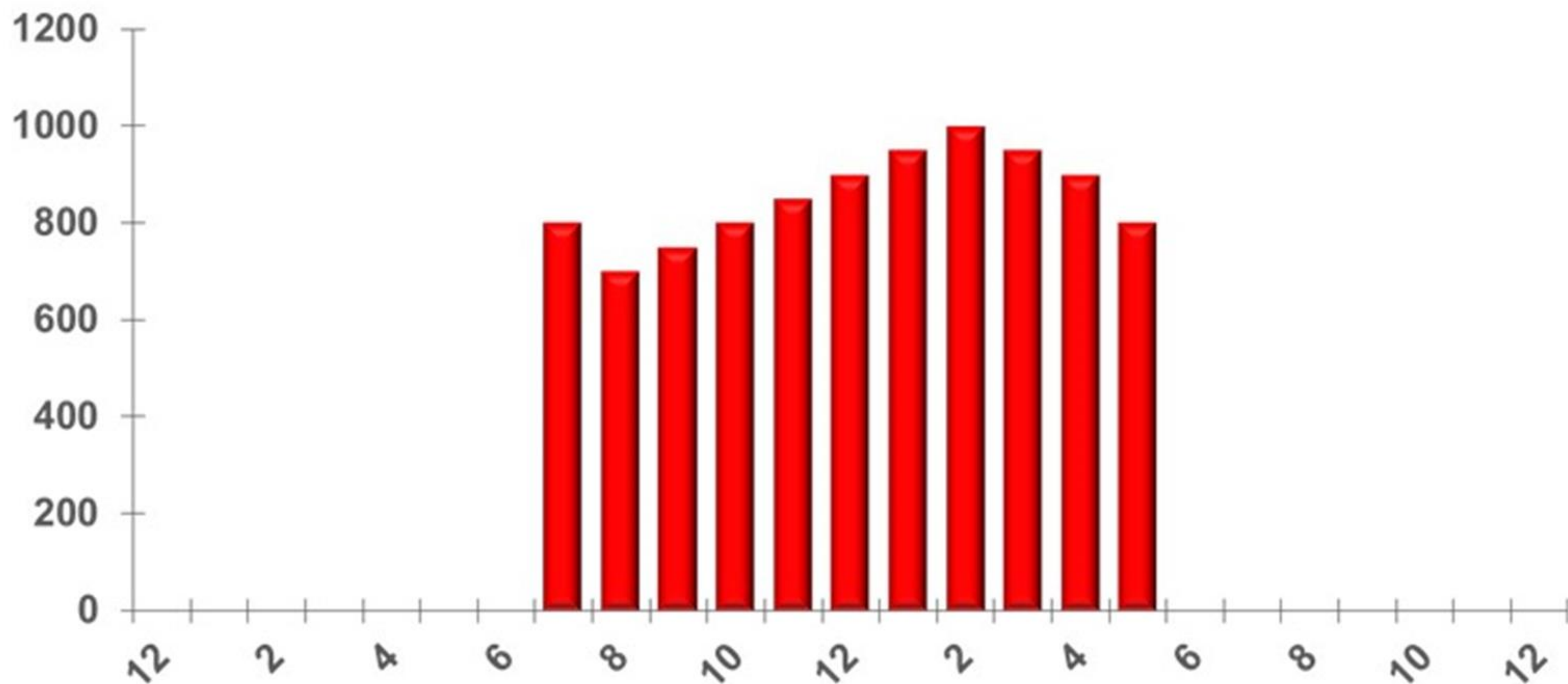


# Basic Schematic





# Building Resiliency Design Day



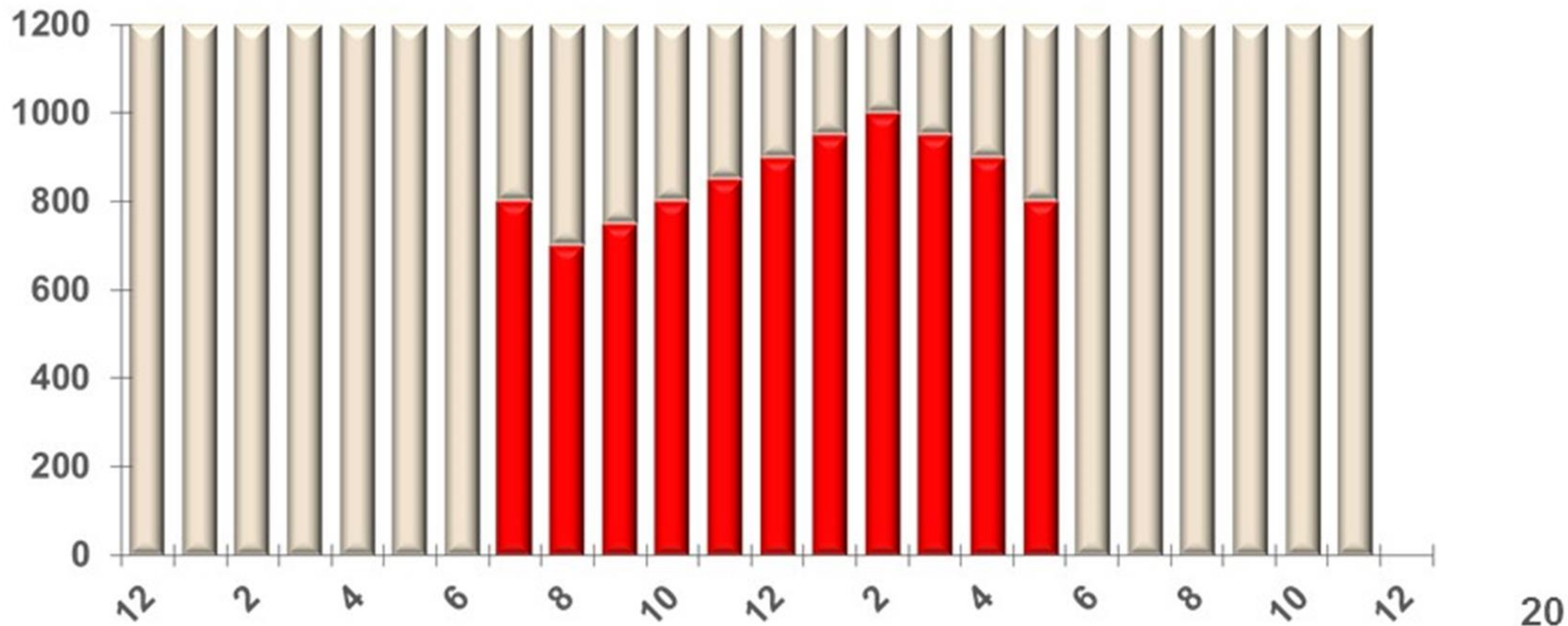


# Building Resiliency

Excess Capacity Design Day Conventional Design

■ Design Day Load

■ Conventional System (3) 400 ton chillers

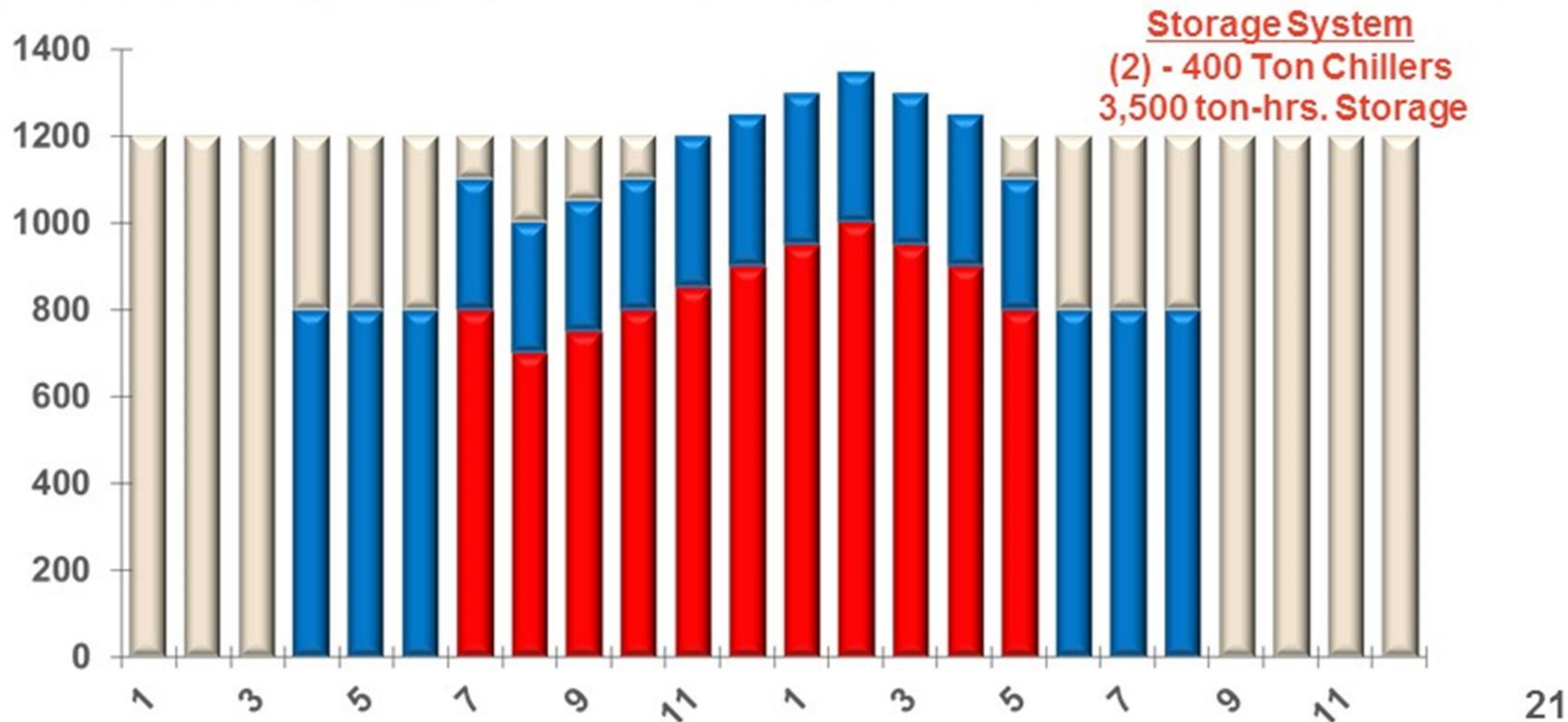




# Building Resiliency

## Excess Capacity Design Day Conventional vs Ice Design

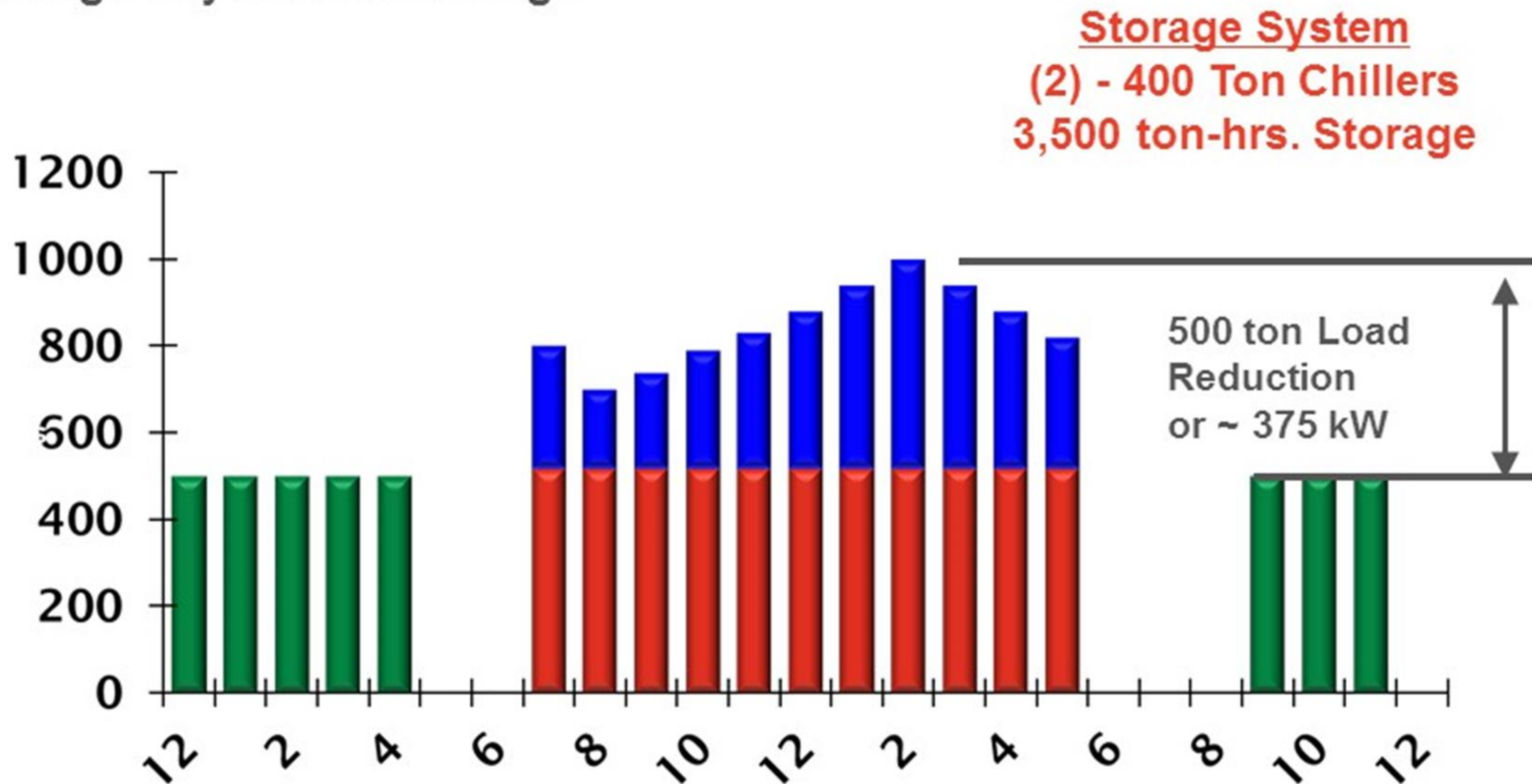
■ Design Day Load ■ Storage System Excess Capacity ■ Conventional System (3) 400 ton chillers





# Building Resiliency

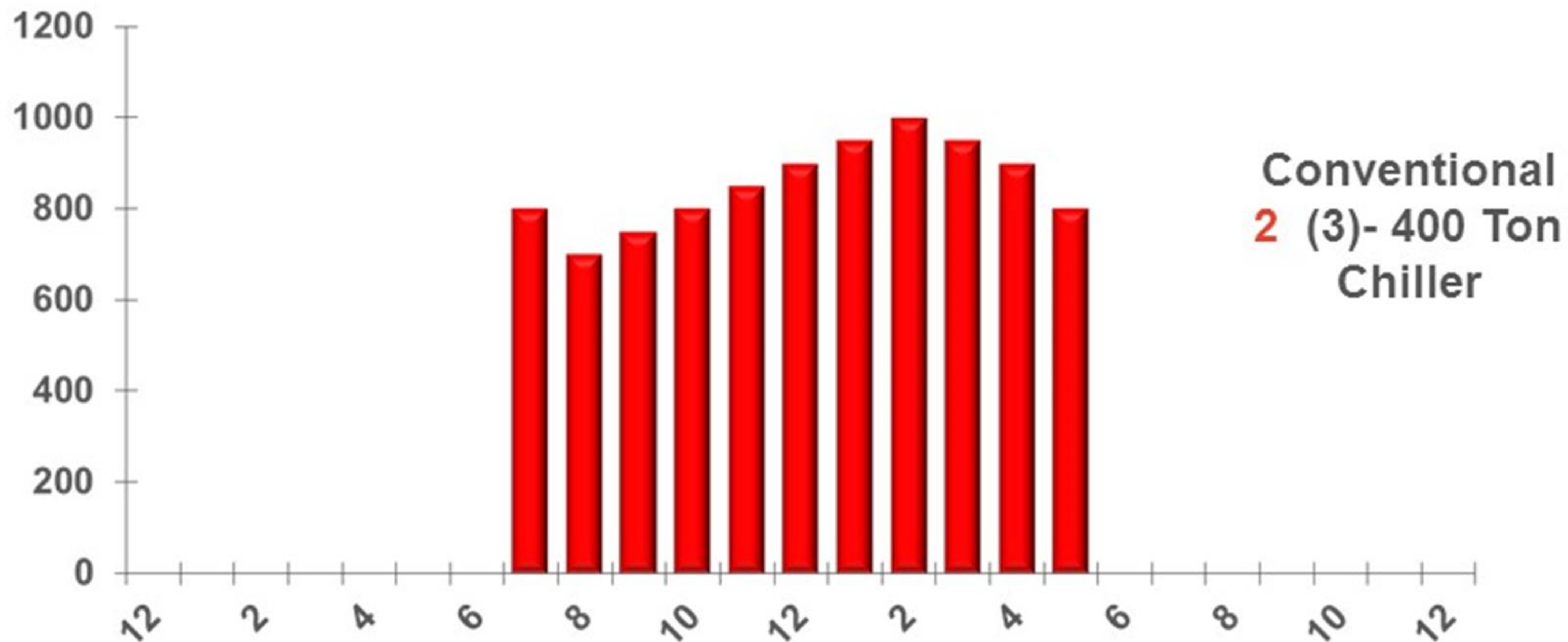
Design Day with Ice Storage





# Building Resiliency

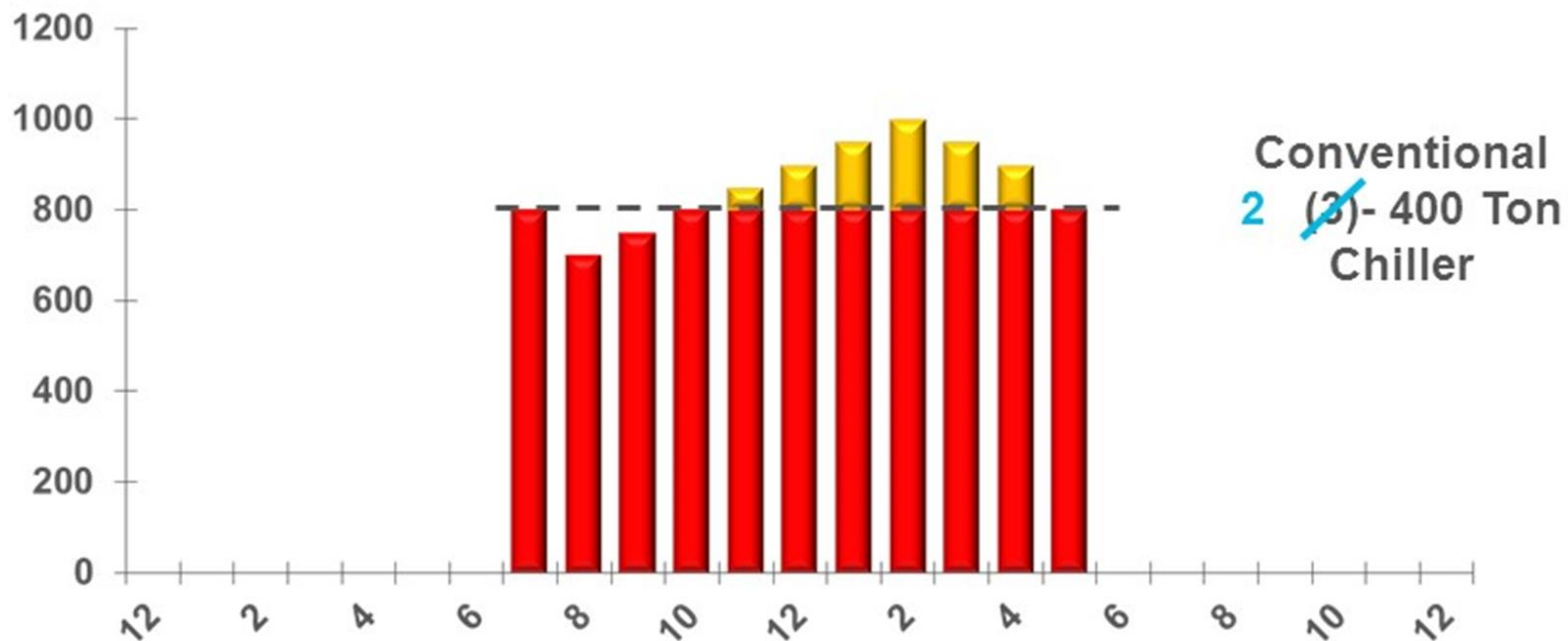
## Design Day





# Building Resiliency

## Design Day Conventional Chiller Failure





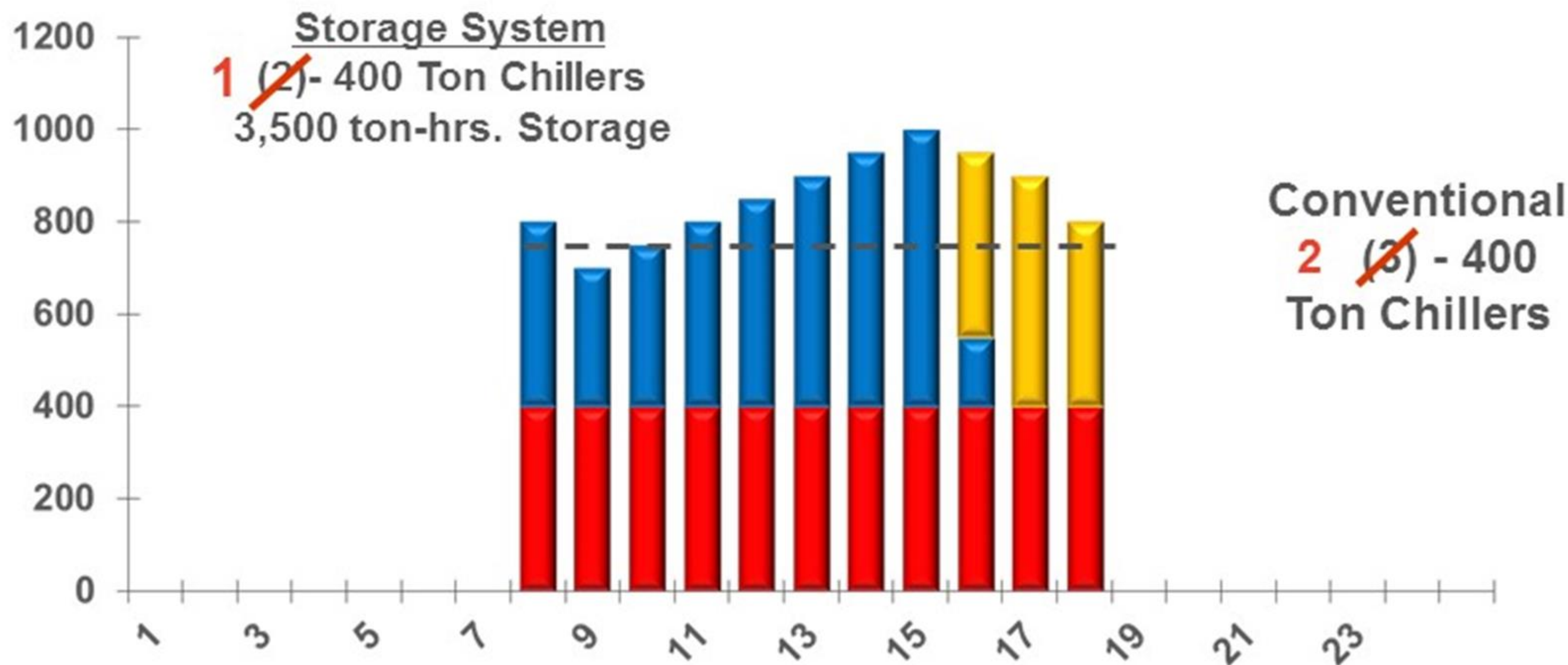
# Building Resiliency

## Design Day Ice Storage Chiller Failure

■ Single Storage Chiller

■ Stored Cooling

■ Storage System Shortfall





# How Do You Pay For Energy Storage?

**Electricity is**



**50% OFF**

**at night or more!**



# The Demand Charge Effect Simplified

Duke Power – Progress Rate LGS-42A

Energy (usage):

**Day: \$0.052/kWh**

**Night: \$0.052/kWh**

**Demand: \$11.91/kW/Month**

**How big an effect is the Demand Charge?**



# The Demand Charge Effect Simplified

Duke Power – Progress Rate LGS-42A

Energy (usage):

Day: ~~\$0.052/kWh~~ **\$0.124/kWh**

Night: ~~\$0.052/kWh~~ **\$0.052/kWh**

Demand: ~~\$11.01/kW/Month~~

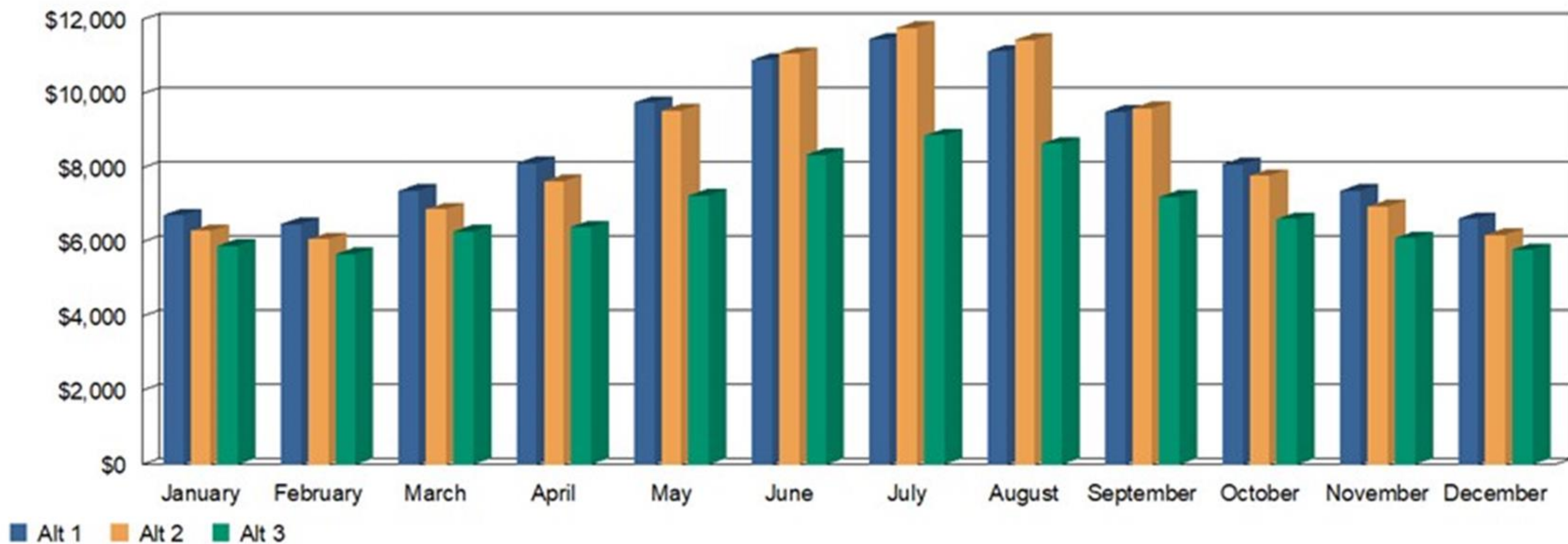
**Energy is up to 58% less expensive at night**

For a daytime peaking buildings cooling



# TRACE<sup>®</sup> Life Cycle Analysis Shows Savings

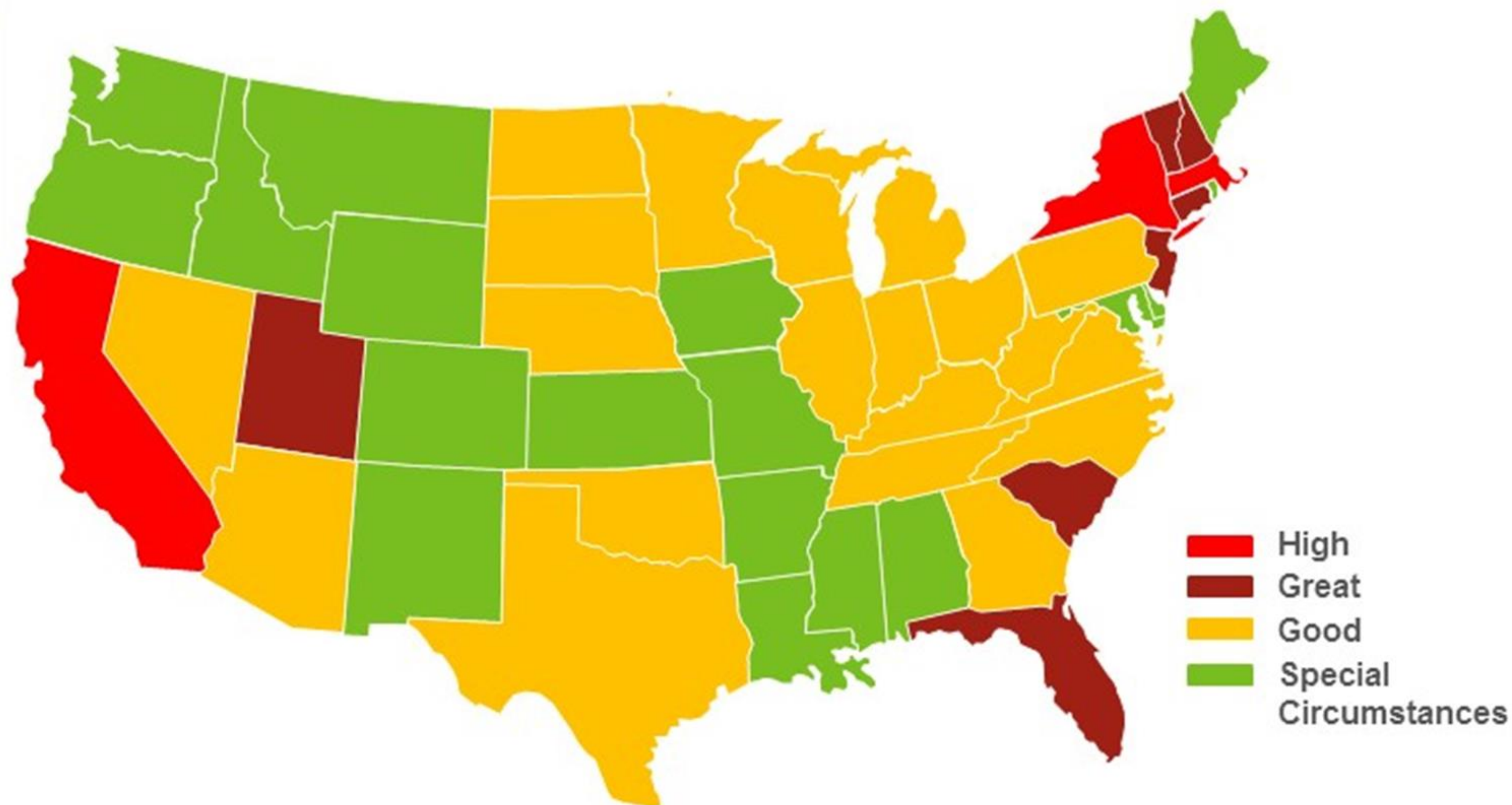
Monthly Utility Costs



**Ratcheted demand charges**

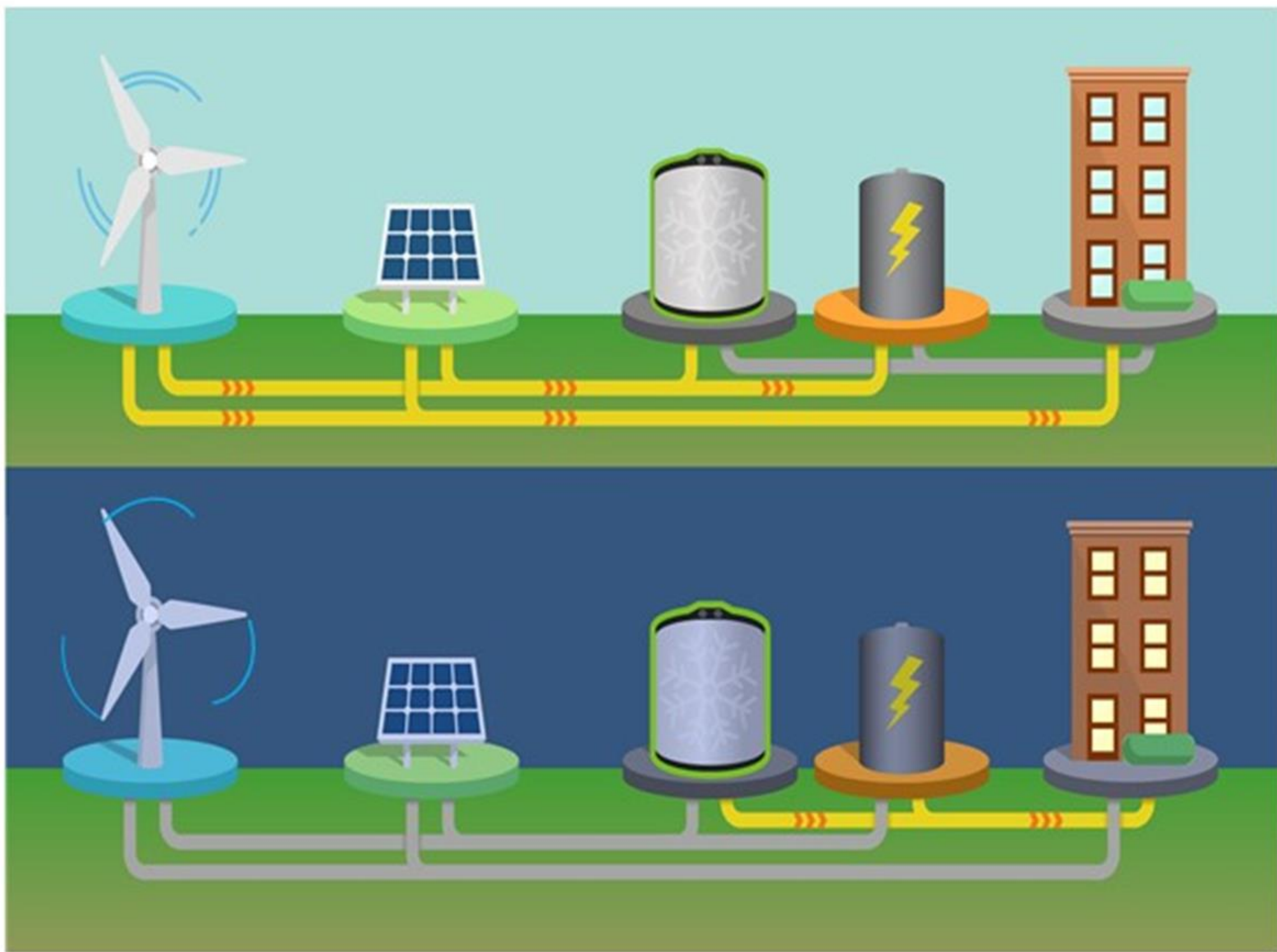


# Places with Energy Storage Potential





# Sustainability



New research shows that **thermal energy storage** increases the utilization of renewable energy by as much as 50%.



# By The Numbers



- 97-99 % Round trip efficiency
- No cycle degradation
- Repeatable Performance
- Re-deployable
- 99% recyclable or reusable

- 89" diameter
- 102" tall
- 2,000 lbs. to ship
- 16,900 lbs. operating

- 160 useable ton hours
- 16 tons - 10 hours
- 20 tons - 8 hours
- 25 tons - 6.4 hours



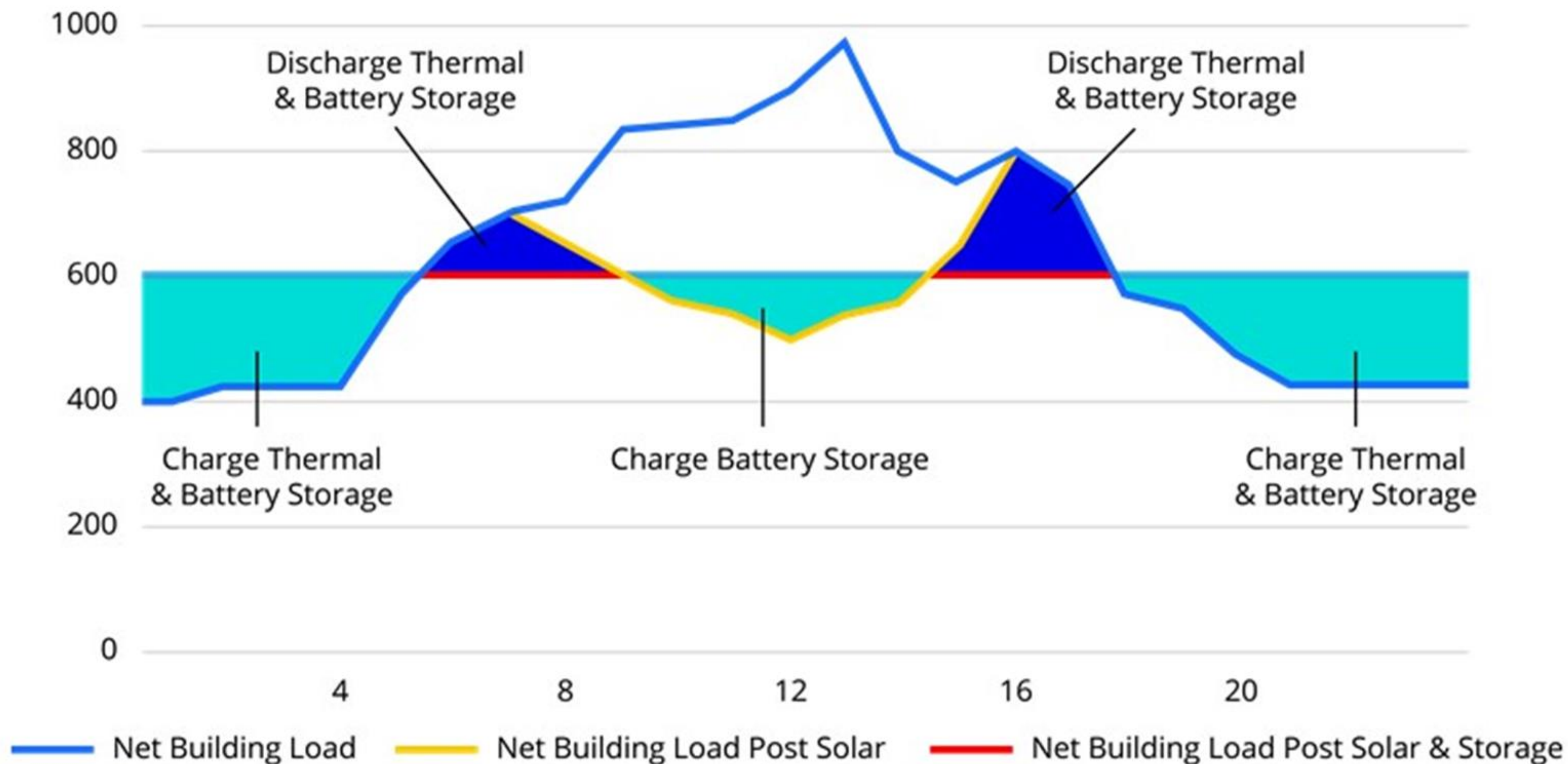
Partial storage footprint is about **1/4 of 1%** of conditioned space

**40 Year Useful Life**



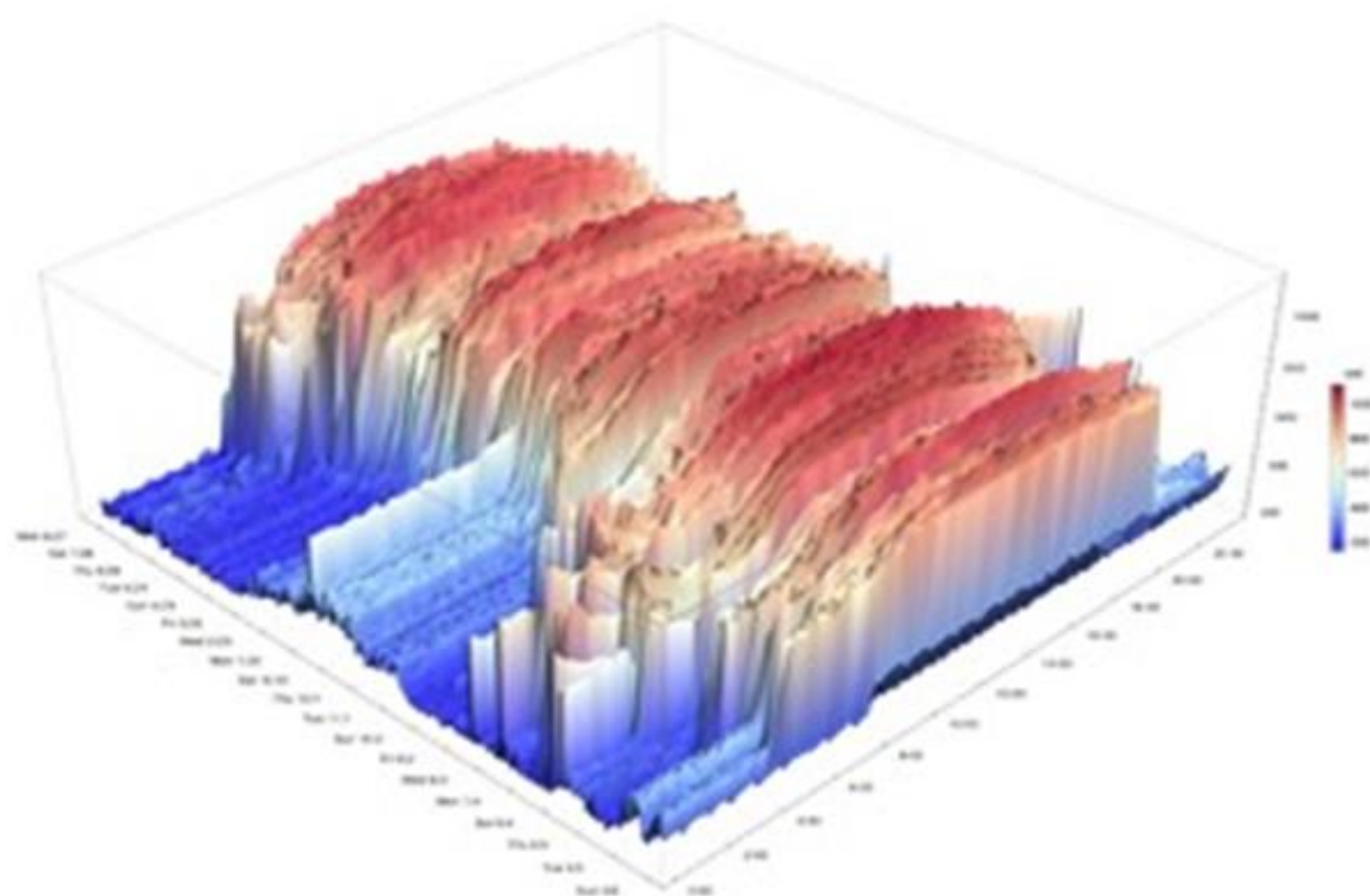
# What's in Your Building?

Buildings with *energy agility* and *energy awareness*  
can have the lowest cost of operation





# Energy Awareness



DER portfolio  
Increase resilience  
and improve  
sustainability

Thermal & battery  
energy storage  
offer greatest peak  
load shift potential



Demand management,  
Controlled.  
Measureable.  
Visualized.



# Exterior System Locations



**Rooftops**



**Partial Burial**



**Total Burial**



# Exterior System Locations



Outside on slab





# Interior System Locations



**Parking Garages**



**Basements**



Joe Riemer,  
Product Support Leader

# THERMAL ENERGY STORAGE CASE STUDY





# University of Arizona

## Situation

- Electricity
  - Purchase at 7.5-8.5 cents / kWh
  - Generate at 4-5 cents / kWh
- Ice flattens the load profile
  - Helpful in utility rate negotiations

## Physical Plant

- 3 chilled water plants (total)
  - 21 chillers
  - 33,000 tons
- All plants connected
- All served by Trane Tracer® control system





# How Can The Ice Be Better Utilized?

- Operate turbines more hours
- Utilize ice with other infrastructure



# Combined Heat and Power (CHP)

- 6.5 MW, gas-fired turbine generator
- Auxiliary 1.7 MW steam turbine generator
- 33,000 pph (pounds per hour) of 125-psi steam
  - Medical Center
  - Sciences Center



Fully utilized during the day



Night-time

- Campus electrical loads low
- Need for sterilization, laundry, etc.
- Needed to run boiler



# The Twist – Fire & Ice



- Operate gas-fired turbines
  - Higher efficiency
  - Heat recovered for Medical Center
  - Boilers off
- **Make** ice
  - Operate chillers to produce ice
  - Fully load turbines
  - Tower temperature reduced at night

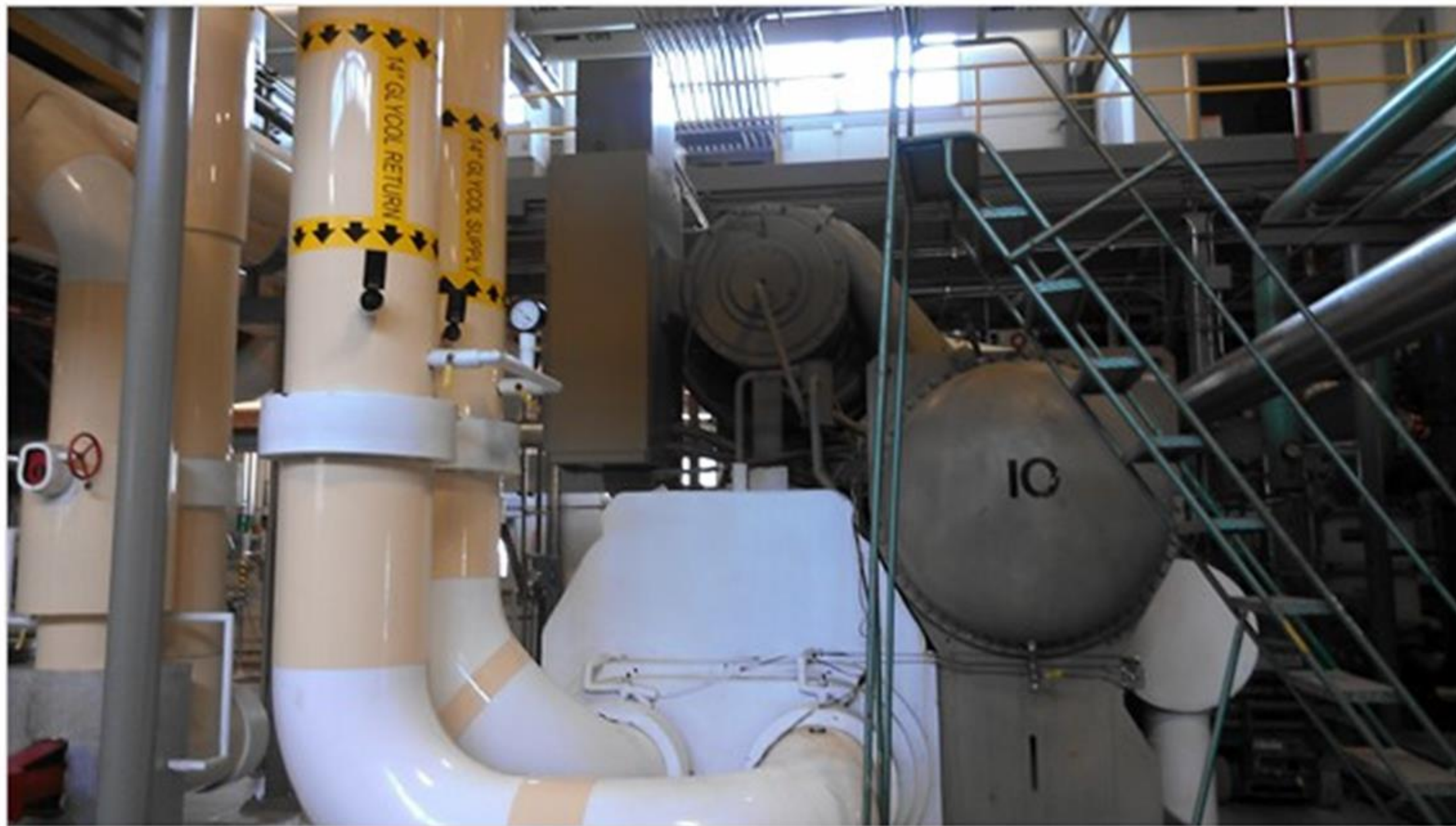


- Operate gas-fired turbines
  - Heat recovered for Medical Center
  - Boilers off
- **Melt** ice
  - Peak load reduction



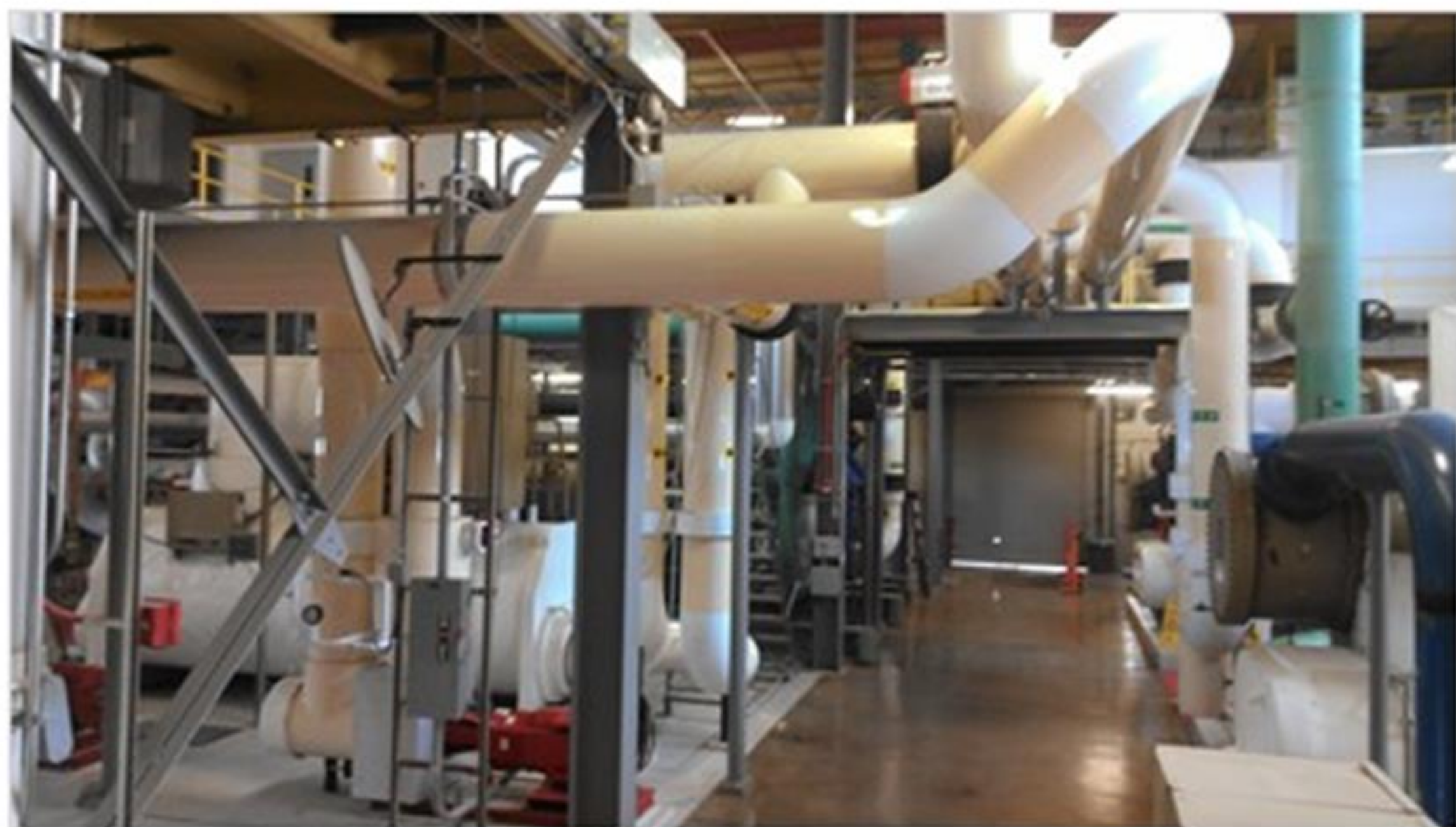
# University of Arizona Ice Plant

- **156** ice tanks
- **23,400** ton-hours
- Ice storage saved **\$423,000** /year  
(up to **\$38,000** /month)





# It Worked So Well... More Storage Was Added



- **1,250** ton chiller
- **7,350** ton-hours (**49** tanks)





*“Ice storage has given us the flexibility we needed to maximize our efficiency with the production and use of energy.\*”*

University of Arizona



# CREATING A HOLISTIC ENERGY PLAN





# Questions?

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