Thermal Batteries: Low-Cost, Scalable Grid Storage to Achieve Energy Goals

February 11, 2025

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The panel will discuss the latest innovations in thermal energy storage and why they are important, especially with the new investment tax credit included in the Inflation Reduction Act of 2022. The session will cover how thermal batteries interact with the grid, how they provide affordable solutions to achieve energy goals, and the economic and carbon-reduction benefits to end-users.

Moderator:

Makenzie Horrigan, Senior Manager, International and Domestic Policy, AHRI

Speakers:

Laura Marshall PE, Applications Lead – Refrigeration, Baltimore Aircoil Company
James Marker, Director, Business Development, Ice Energy
Ori Asscher, Senior VP, Engineering and Operations, Nostromo
Al Takle, ETS Business Unit Leader, Steffes

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Program

- Introduction
- What is thermal energy storage and why is it important?
  - Economic benefits
  - Grid benefits
  - Carbon reduction benefits
- Case studies and applications of thermal energy storage technology

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We Are Familiar with Energy Storage

Electric

Thermal

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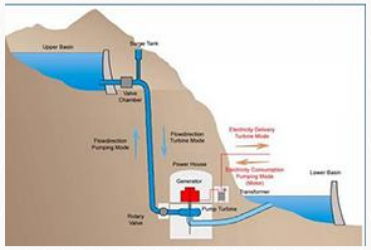
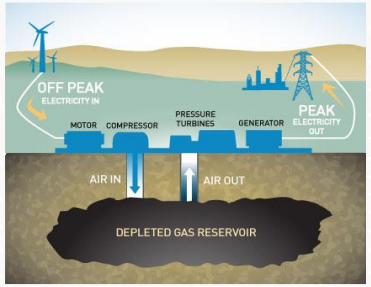
Grid Scale Energy Storage

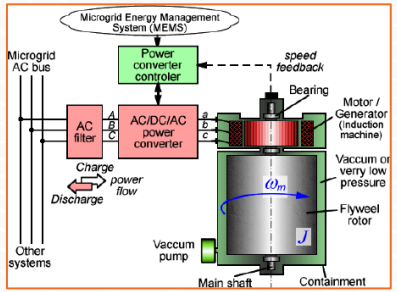
Pumped Hydro



Battery

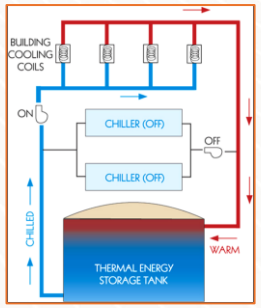
Compressed Air

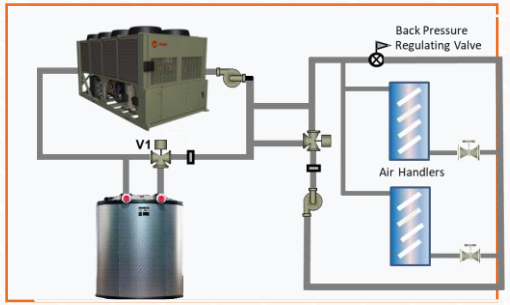




Flywheel

Thermal Energy Storage (TES)





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Comparison of Grid Scale Energy Storage

Per DOE Report July 2019

Energy Storage Technology	Eff (%)	Useful Life (Yrs)	Capital Costs ($/kWh)
Pumped Hydro	80	>25	165
Na-S Batteries	75	14	907
Lead-acid Batteries	72	3	549
Li-Ion Batteries	86	10	469
Flywheels	86	>20	11,520
Compressed Air	52	25	105
Thermal Storage (TES)	93 - 100+	>50	30 - 500

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Definitions: Thermal Energy Storage (TES)

- Thermal storage systems remove heat from or add heat to a storage medium for use at another time
- Energy may be charged, stored, and discharged daily, weekly, annually, or in seasonal or rapid batch process cycles
- Fast-acting and/or grid-interactive energy storage systems can provide balancing services and other critical needs of the electric grid
- These grid-interactive systems dynamically couple consumer energy usage to the grid's real-time needs
- Thermal energy storage for HVACR and/or domestic water heating applications can involve various temperatures associated with heating and cooling

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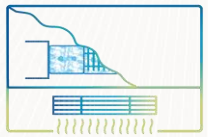
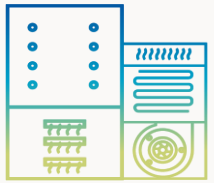
Space Heating Thermal Energy Storage Products





	Room Units	Forced Air	Hydronic
Load Reduction Capacity	1.3 kW – 10.8 kW	14 kW-45.6 kW	14kW – 80kW
Storage Capacity	13.5 - 40.5 kW/h	80-240 kW/h	120-440 kW/h
Ideal Customer setting or use case	Residential Mini-Split Heat pump backup Condos/Apartments	Residential Small commercial	Residential Commercial

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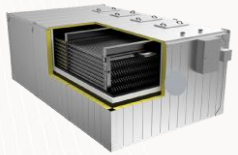
Ice Thermal Storage Products



	Modular Batteries & Medium Tanks	Ice Coil Stacks
Load Reduction Capacity	4 kWh – 15,000 kWh	> 15,000 kWh
Storage Capacity	10-10,000 ton hours	> 10,000 ton hours
Ideal Customer setting or use case	Medium to Large Commercial Cooling	Large Scale District Cooling

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Value of Thermal Energy Storage

1. **Load Shifting & Demand Management**
   - ROI difference between day/night utility rates
   - Demand charge avoidance
2. **Grid Stability & Renewable Energy Integration**
   - LEED points/sustainability initiatives
   - Emergency standby
3. **Resiliency**
4. **Energy Efficiency & Decarbonization**
   - Replaces less efficient heating systems
   - Electrification support reduces carbon footprint
   - Reduce chiller/cooling tower size
5. **Enhanced Power Quality**
6. **Tax Incentive Awards and/or Rebates**

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Economic Benefits for Owners

- **Reduce Energy Costs**
  - Permanently reduce peak electric demand (kW)
  - Reduce time-of-use consumption costs (kWh)
  - Reduce peak electric consumption (by operating during cooler ambient conditions)
  - Utilize a more beneficial electric rate structure
- **Avoid Capital Costs**
  - Instead of adding more refrigeration equipment – add a TES system
  - Instead of replacing an existing chiller – add a TES system
- **Manage Thermal Imbalances** – Store cold or hot water from a geothermal system or capture waste heat from a combined heat and power system for later use
- **Provide Resiliency** – Utilize the TES system as a backup for mission critical operations

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Why are There Utility Rebates and Tax Credits for Thermal Energy Storage Equipment?

- Price of Purchasing Energy on the Peak Consumption Days
- Price of Lower Carbon
- Generation Elimination or Deferral
- Transmission Elimination or Deferral
- Distribution Elimination or Deferral

Lower Electric Rates!

Reduced Carbon Emissions!

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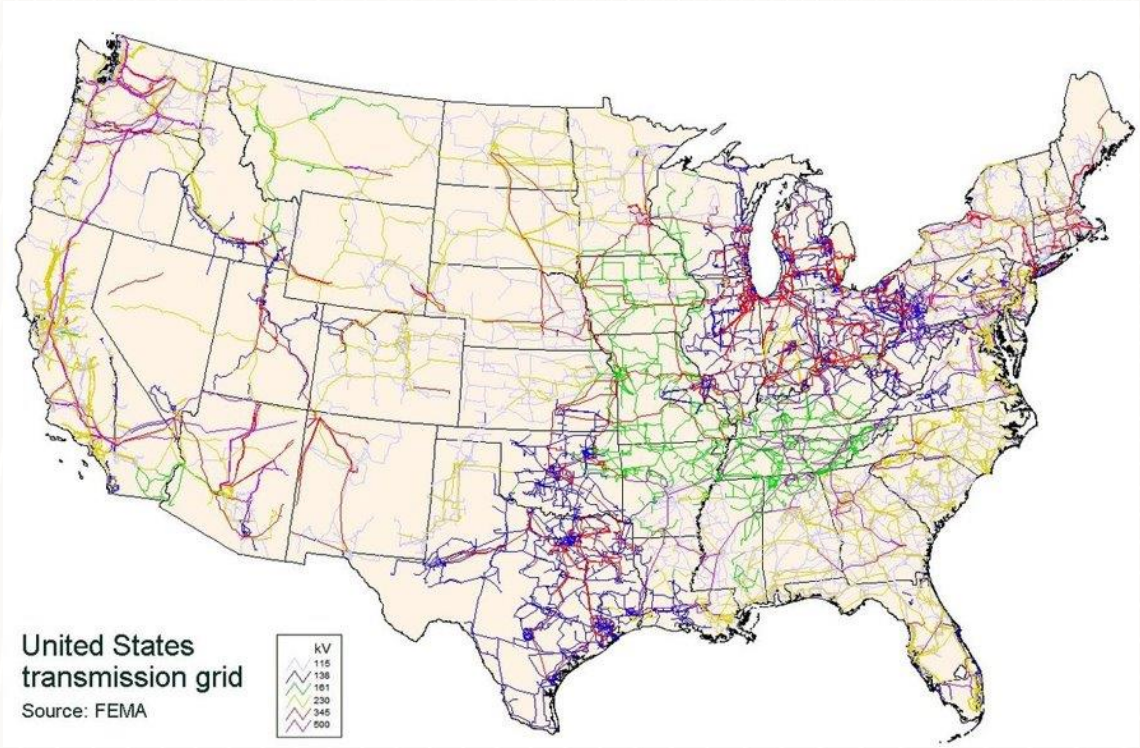
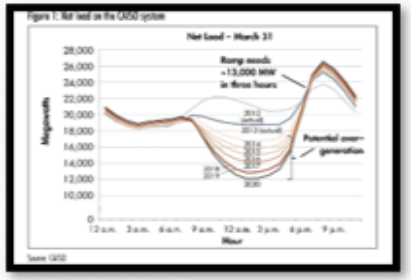
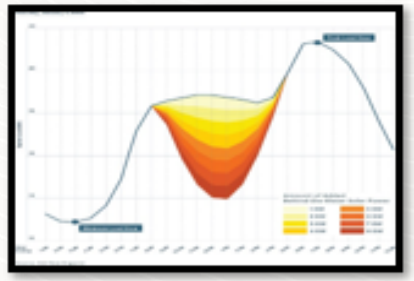
Grid Benefits

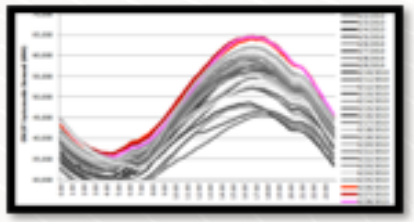




California – “Duck Curve”



Texas – Summer



Massachusetts – Winter

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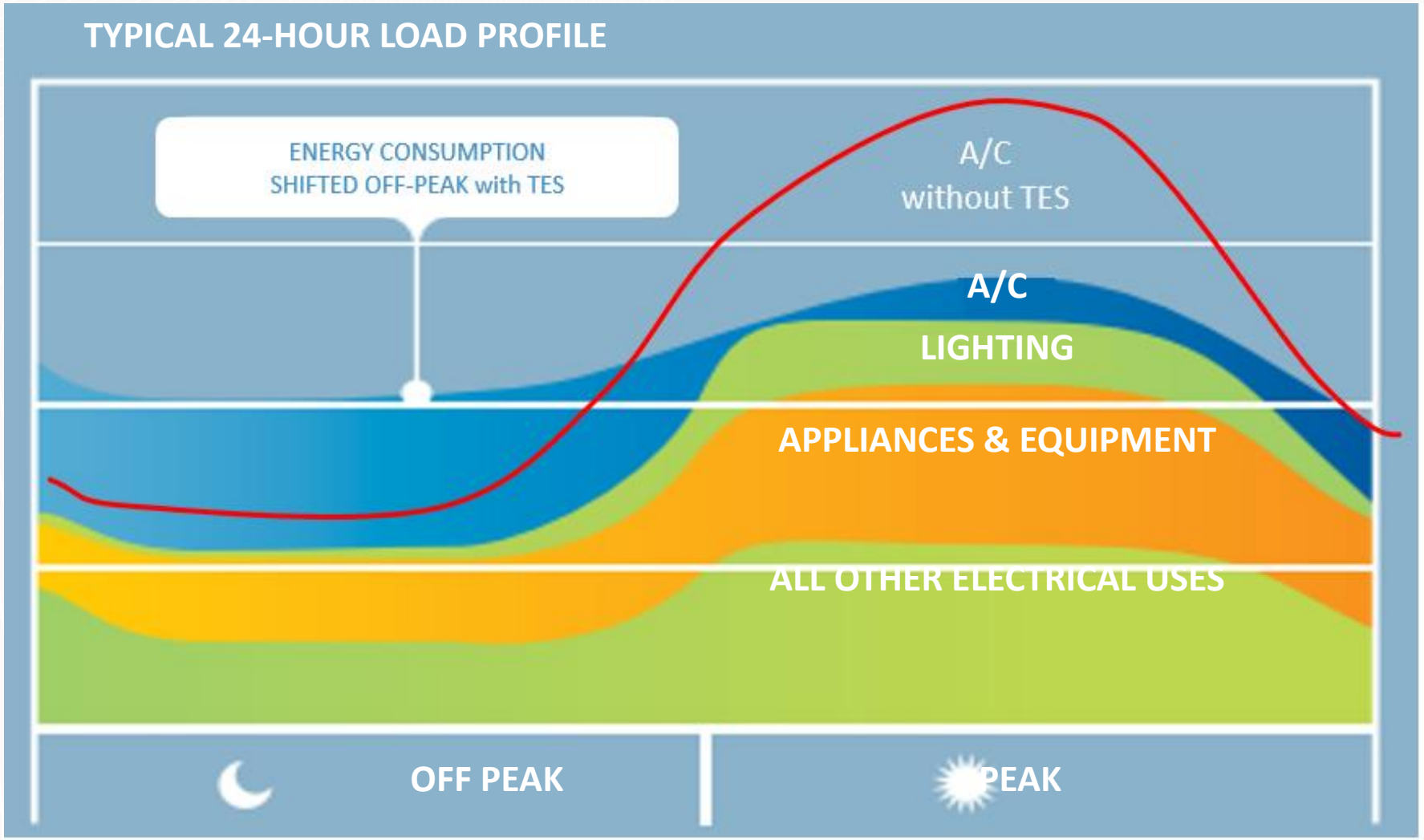
Grid Benefits



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Renewable Enabler

- Wide use of renewable energy requires sufficient storage
- Provides low-cost, long-life storage
- Use of renewables significantly reduces carbon footprint of heating and cooling

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Thermal Energy Storage: A Safe and Sustainable Solution

- Environmentally friendly: No critical minerals or electrolytes used
- Non-flammable: Enhanced safety for urban and high fire-risk areas
- No toxic emissions: Eliminates hazardous gas release
- Ideal for sensitive areas: Safe, scalable energy storage solution

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WATER!

Common
Recyclable
Clean
Cheap
Zero degradation

A rare earth material
Non-recyclable
Expensive
Unsafe
Harmful extraction
Highly degradative

not Lithium

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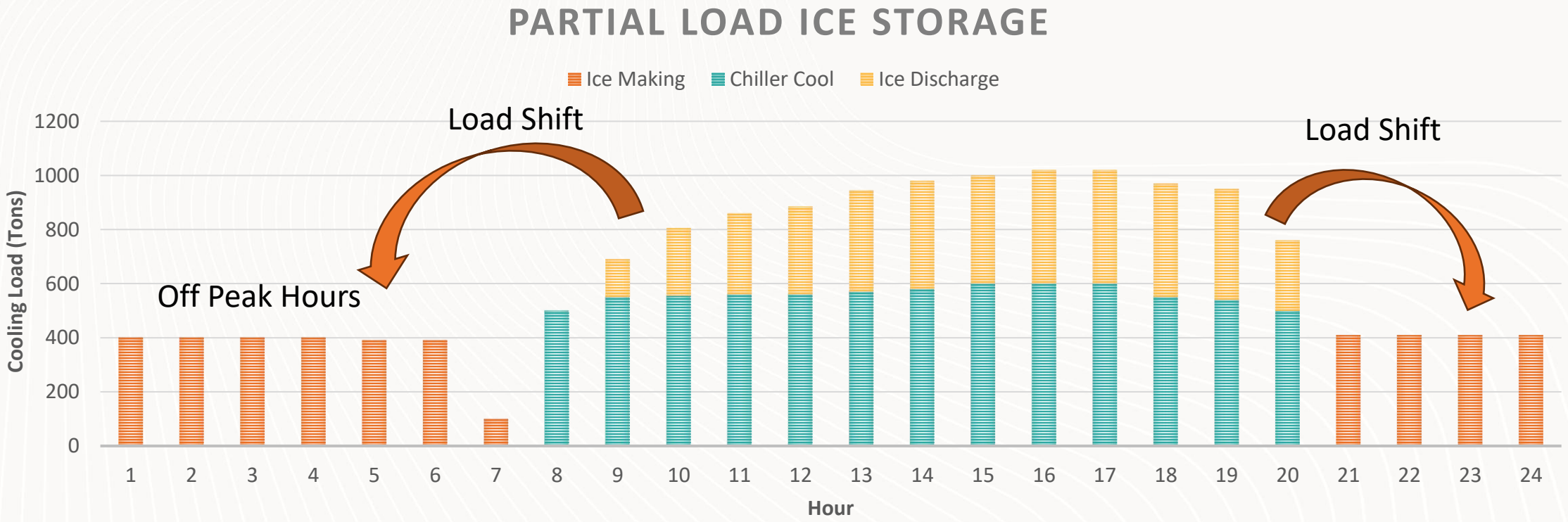
Customer Benefits

- Reduces peak electric demand
- Reduces operating costs



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Applications

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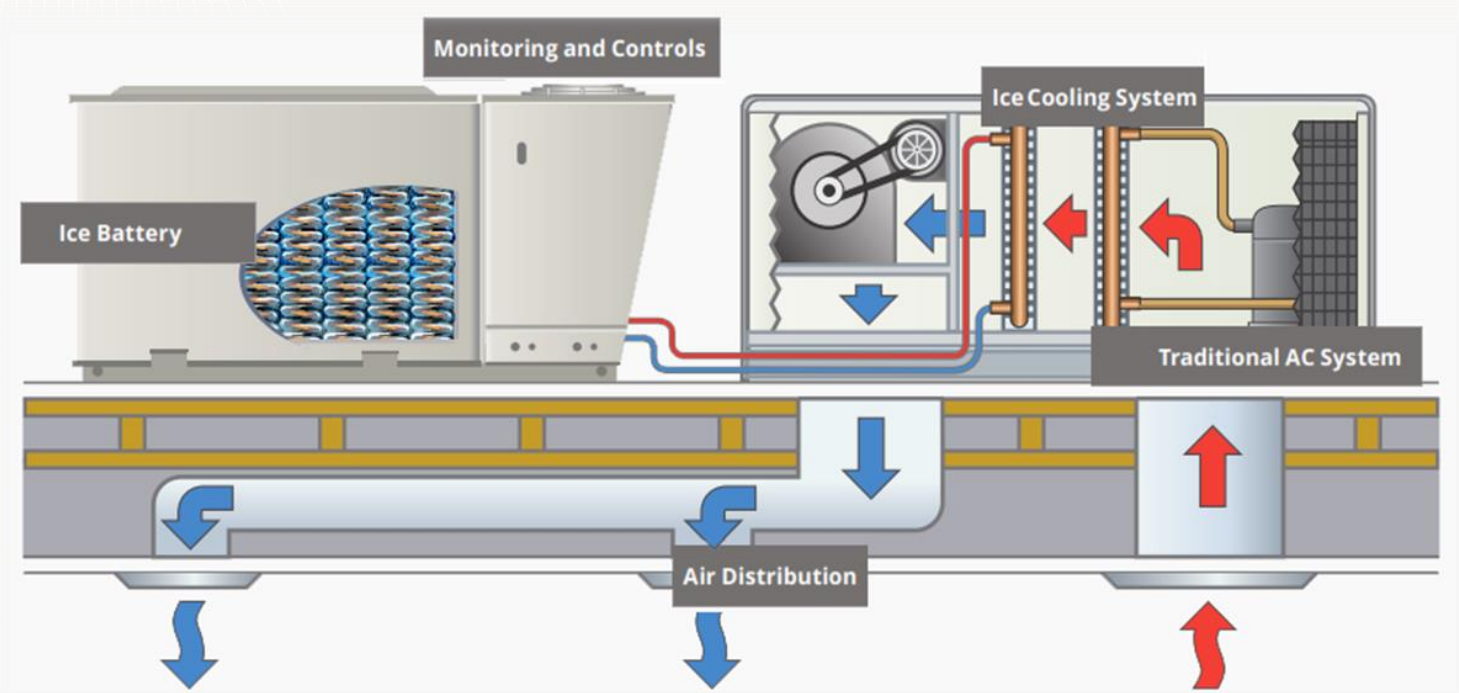
Simple Concept: Use Ice to Cool Buildings

Commercial Applications

- Ice is created during low-cost off-peak times of day or when solar is available
- Refrigerant lines run to a new coil in the RTU
- RTU's compressors do not turn on during warmest, harshest times of year



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Versatile Applications

Offices

Hotels

Industry

Government

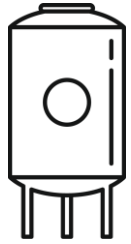
Hospitals

Large Scale Retail

Education

Data Centers

District Cooling



Dairy Tanks

C&I To do their part

Source: Woods Mackenzie, McKinsey.

244,500 chiller-cooled buildings in USA (excl. industry and data centers).

August Day - Demonstrated a 256kW Demand Reduction

579kw

\- 323kw

256kw

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Eliminating Air-Conditioning Loads via TES

James Marker

Ice Energy

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Simple Concept: Use Ice to Cool Buildings

- Ice is created during low-cost off-peak times of day and/or when solar is available
- Ice storage unit uses the existing equipment from the air-conditioning unit to create ice
- RTU's compressors do not turn on during warmest, harshest times of year

Residential Applications

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A Closer Look: Residential TES

- Only 85in in length, 34.5in wide, and 49in high
- Very low fire risk compared to lithium-ion

Residential Applications

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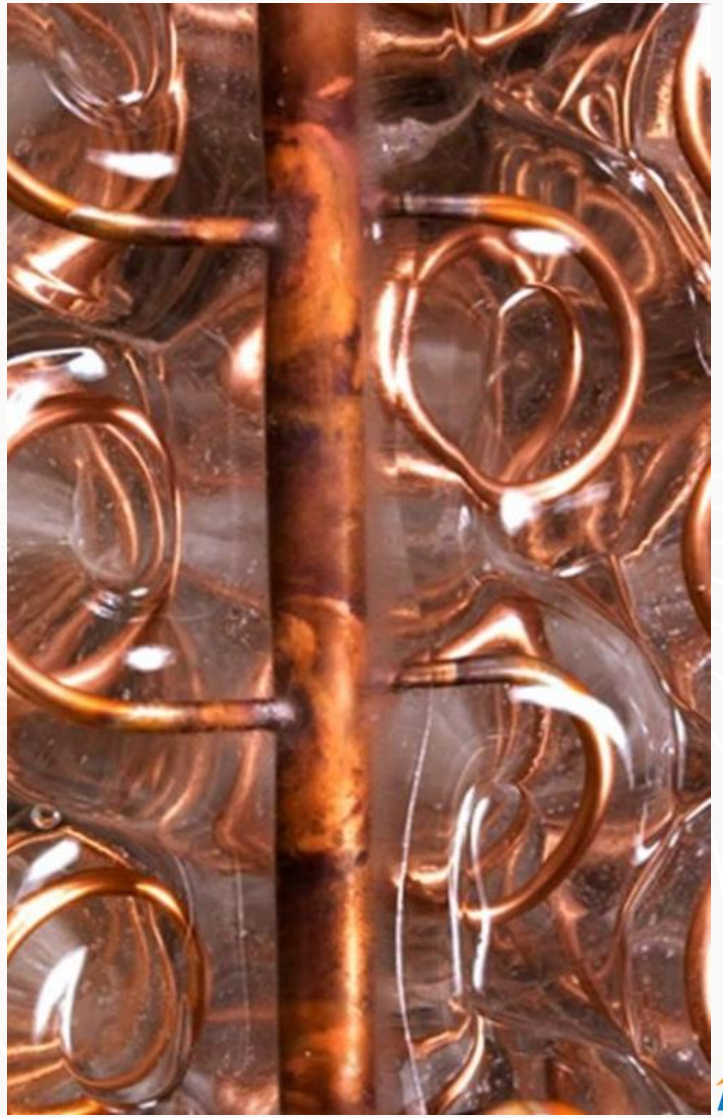
Case Studies

- Contract for 6.5MW at Southern California Edison since 2018.
- Virtual Power Plant: Ice storage deployed on over 100 buildings in Orange County. Each installation communicates through protected cell network.
- Average ice storage equipment saves $3,500 per install. One building will have multiple installed. Service & Maintenance included.
- Over 98% up time for total availability over time since deployment.
- Electronics big box retailer: "The store with the ice storage installed is the best performing store in all of California (146 stores)."



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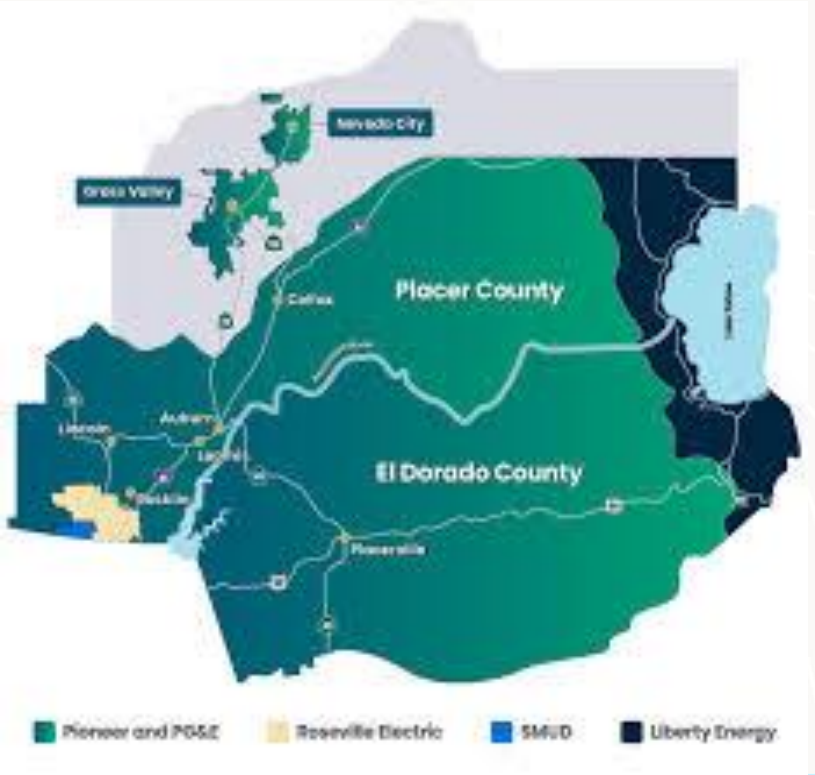
Case Studies

- Community Choice Aggregator Resource Adequacy contract started January first, 2025.
- Created first commercial program for CCA/utility.
- Improving retention of customers, locking in for 20 years.
- Creating storage and energy efficiency program.
- Leveraging contractor alliance networks.
- Utility receives the capacity; each residential customer saves $1,200/yr in TOU rates. Service and maintenance included.

PIONEER COMMUNITY ENERGY



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Ice Thermal Storage

Laura Marshall

Baltimore Aircoil Company

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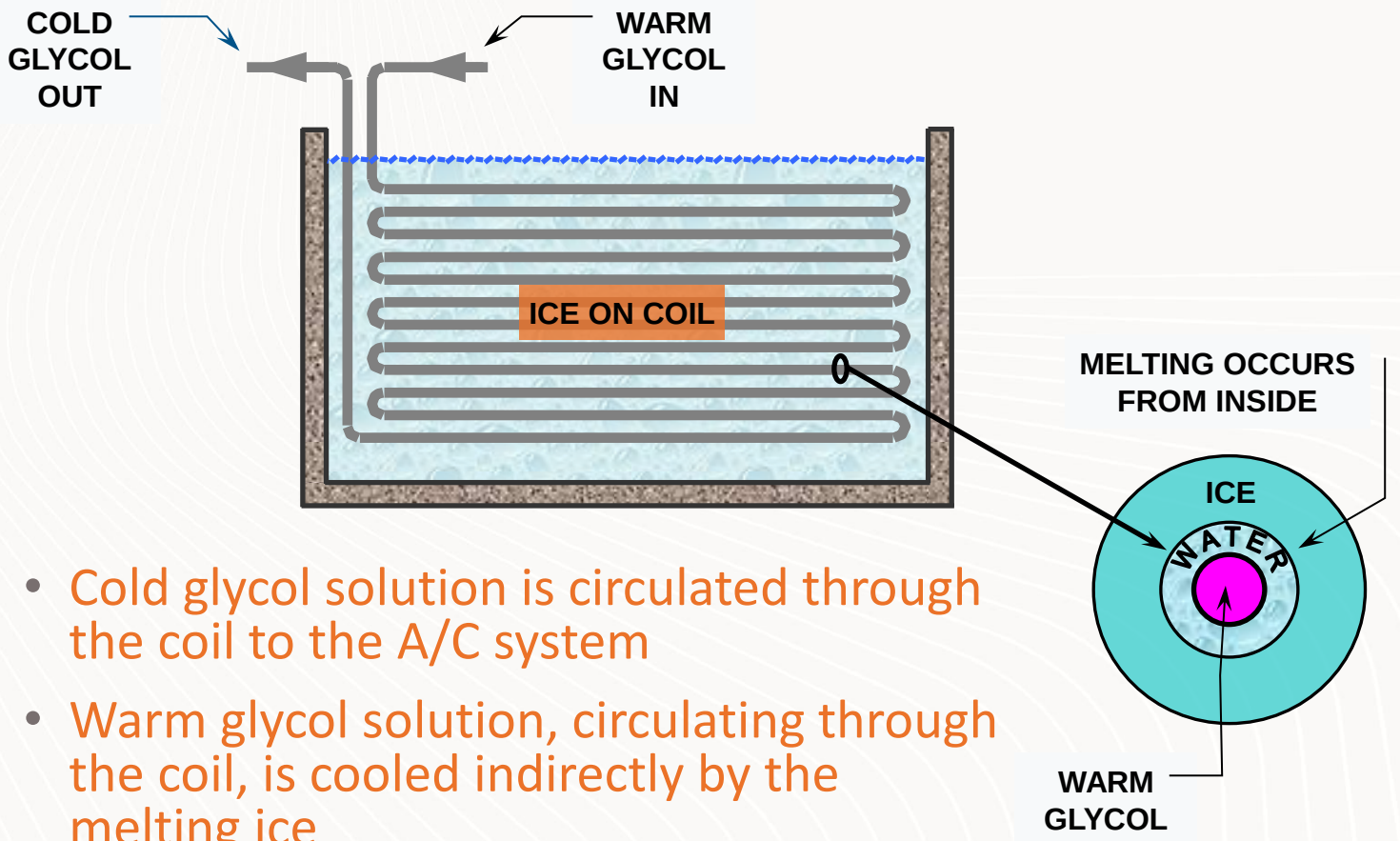
Ice Thermal Storage System Design
Ice on Coil – Internal Melt

Indirect



- Cold glycol solution is circulated through the coil to the A/C system
- Warm glycol solution, circulating through the coil, is cooled indirectly by the melting ice

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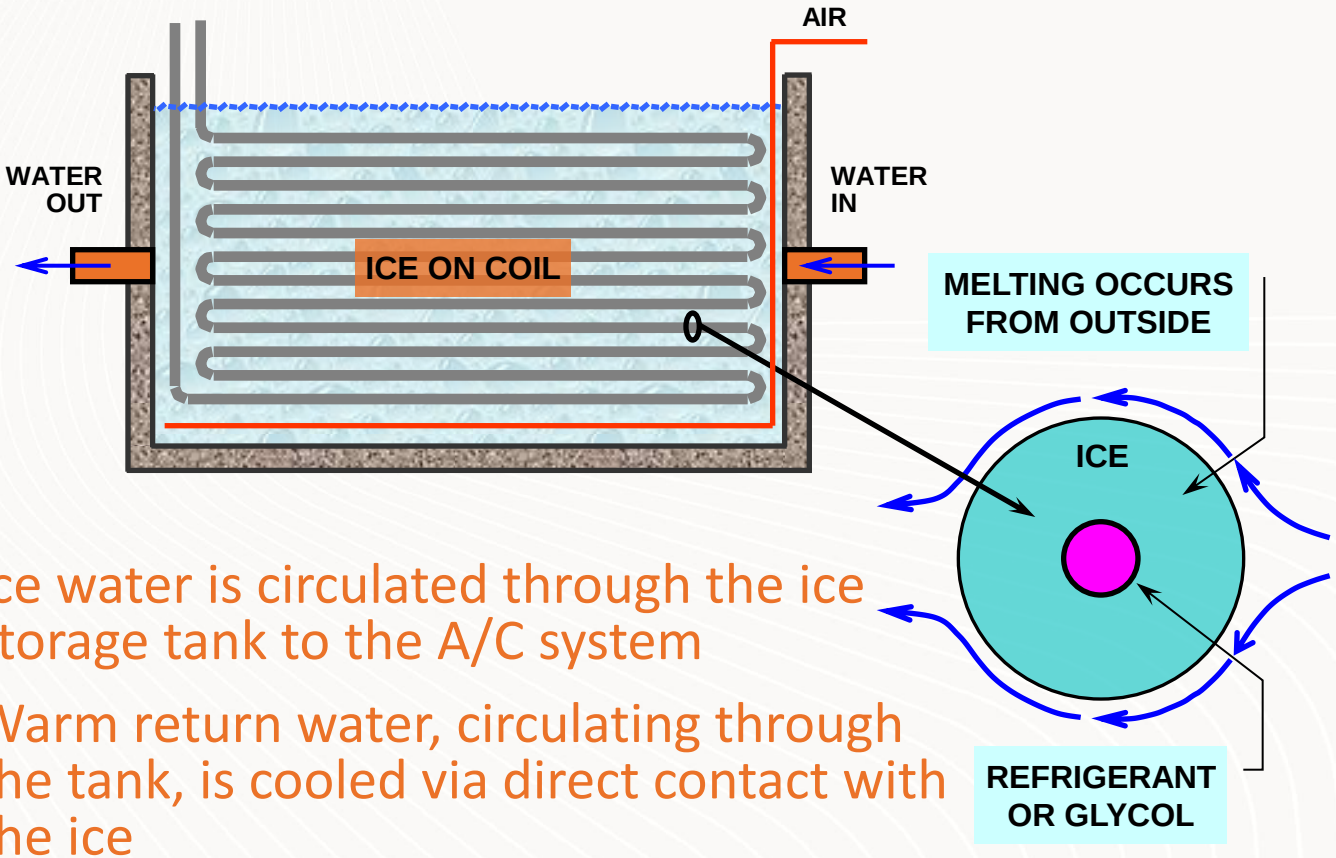
Ice Thermal Storage System Design
Ice on Coil – External Melt

Direct



- Ice water is circulated through the ice storage tank to the A/C system
- Warm return water, circulating through the tank, is cooled via direct contact with the ice

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Nova Southeastern University

- 79,200 Ton-Hours
- Florida Power & Light rebates
- Long pipe runs benefitted from colder melt out temperatures
- Offset electric grid demand to off-peak hours

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Nova Southeastern University

Ft. Lauderdale, FL
(24) TSC-3300ES 79,200 Ton Hours

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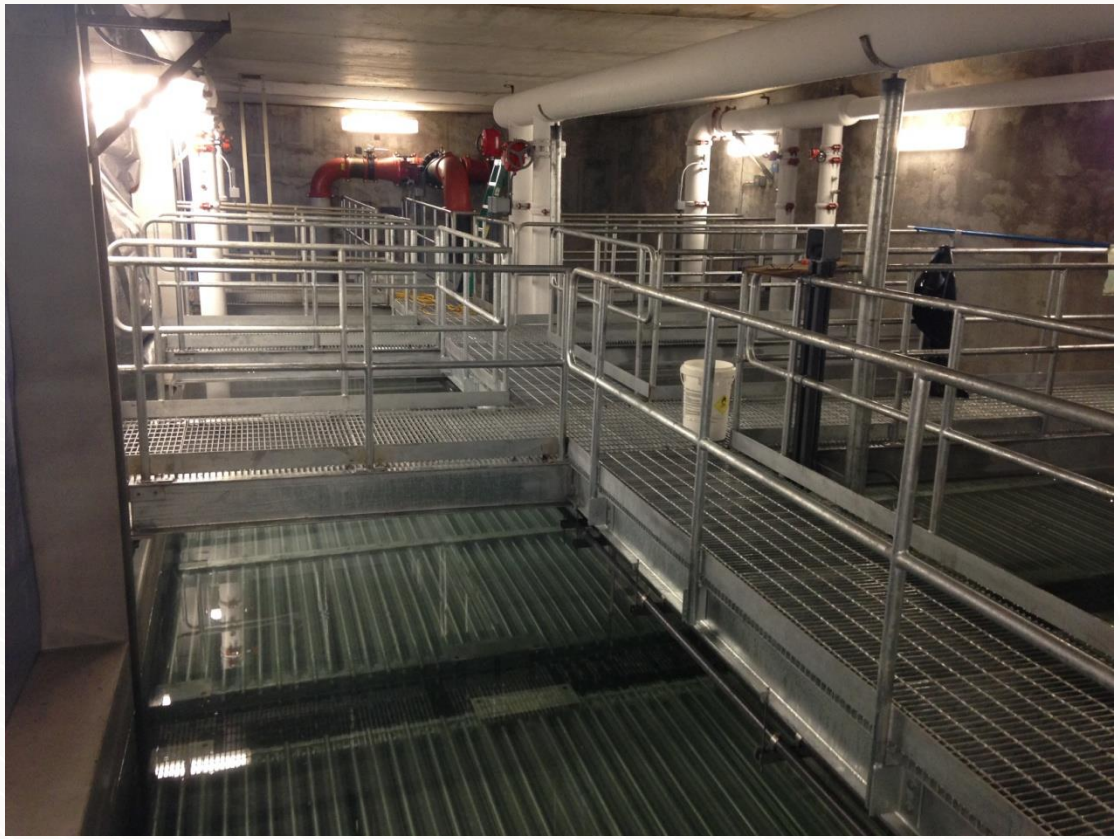
Nova Southeastern University

Ft. Lauderdale, FL
(24) Coils
79,200 Ton Hours



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Molina Healthcare

- 5,900 Ton-Hours
- Southern California Edison rebates
- Updated 30 yr old HVAC system
- Lower monthly bills and redundancy

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Nova Southeastern University

Molina Healthcare
Long Beach, CA
(10) Internal Melt Tanks 5,900 Ton Hours

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Ice Thermal Storage

Ori Asscher

Nostromo

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Buildings consume 74% of electricity

39% of Carbon

CUSTOMER BENEFITS

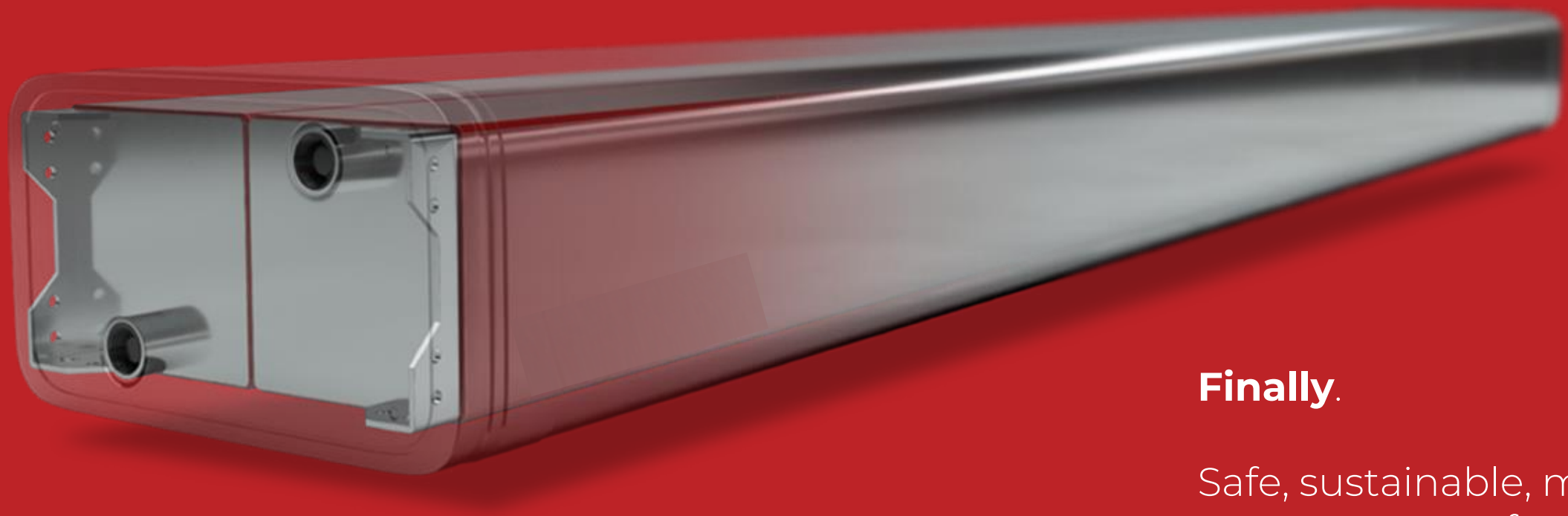
Up to

20

LEED points

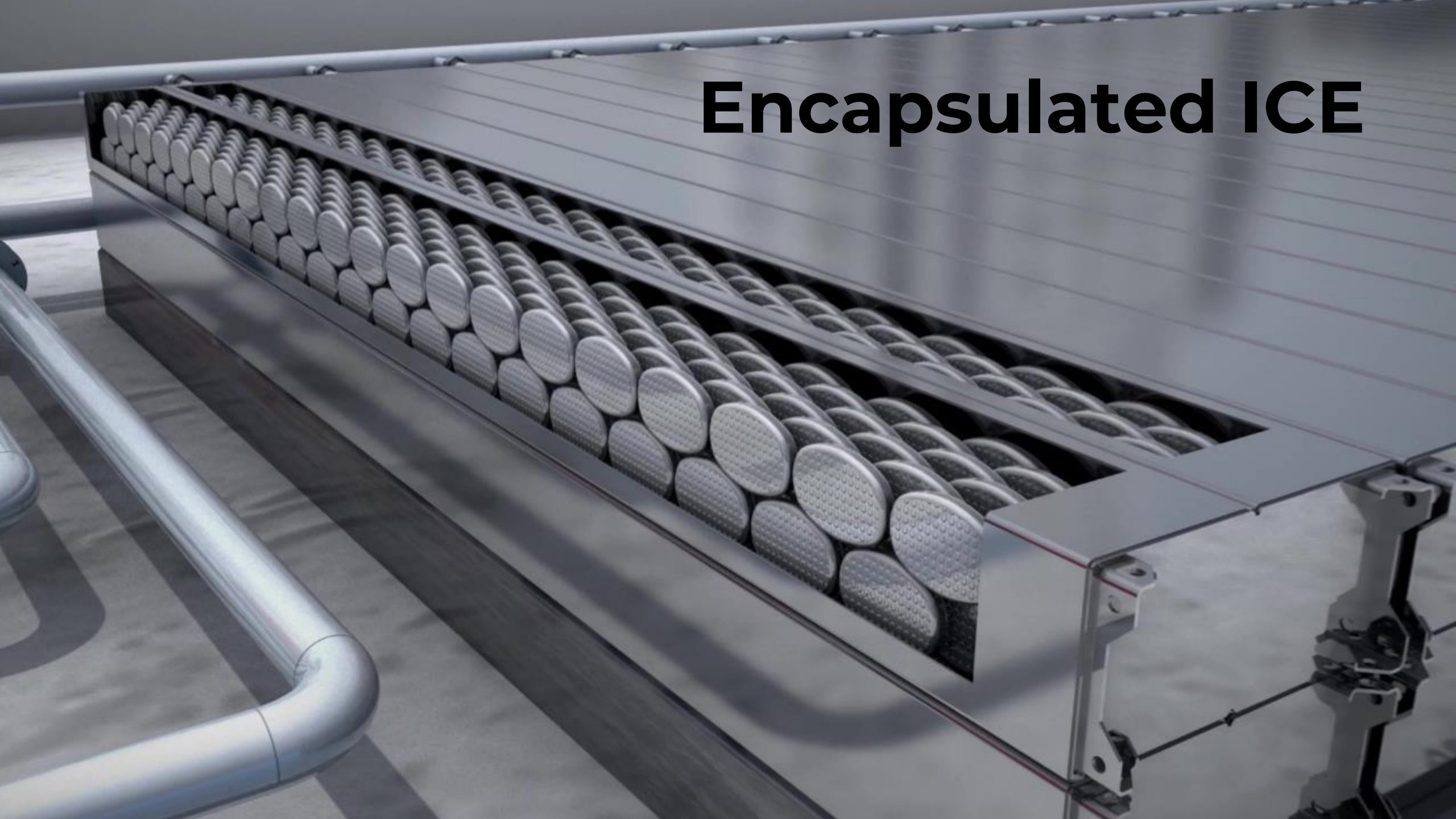
Free-up capacity to charge more EVs

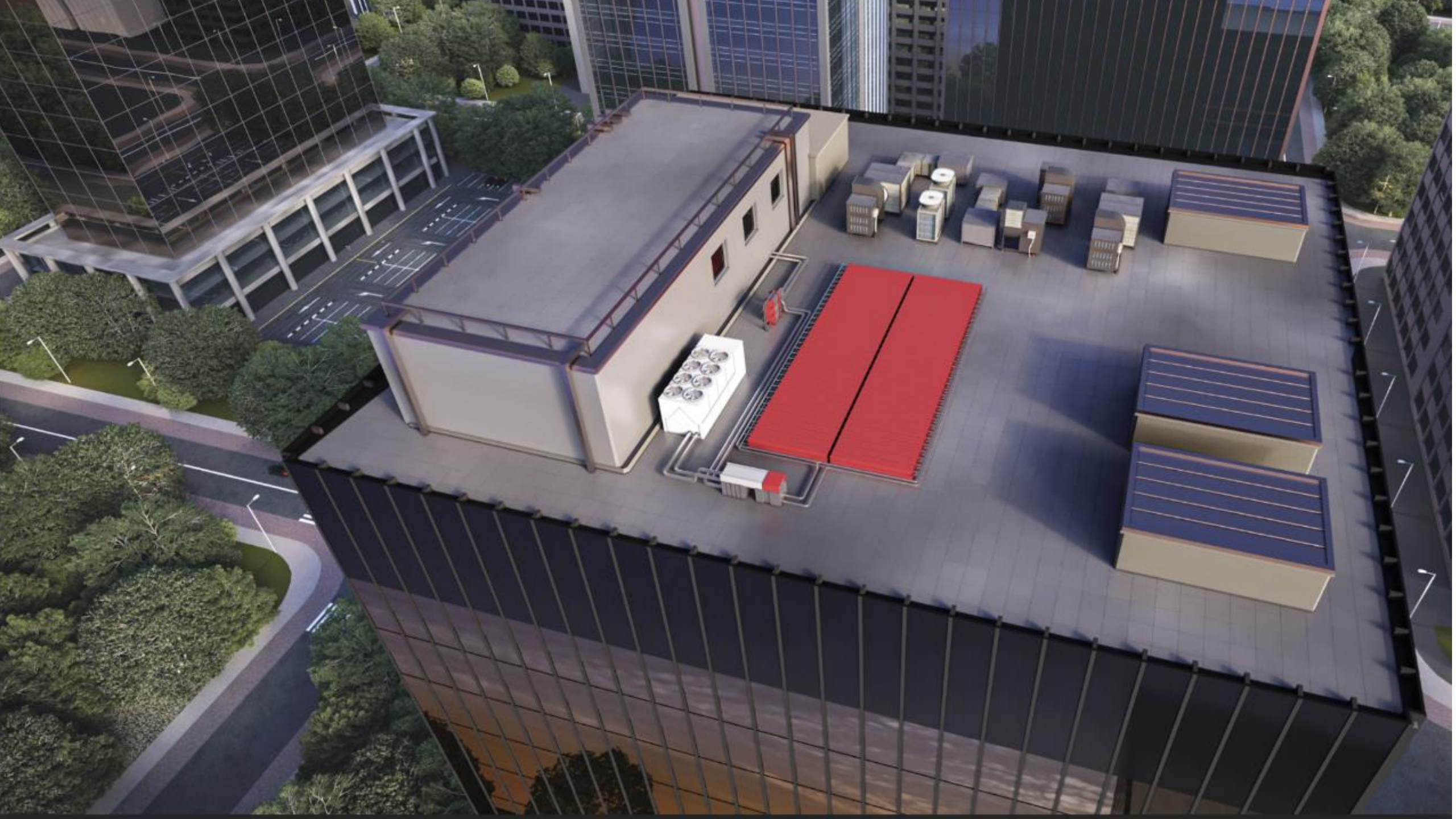
MODULAR ICE BATTERIES



Finally.

Safe, sustainable, modular energy storage for pairing with chilled water systems.

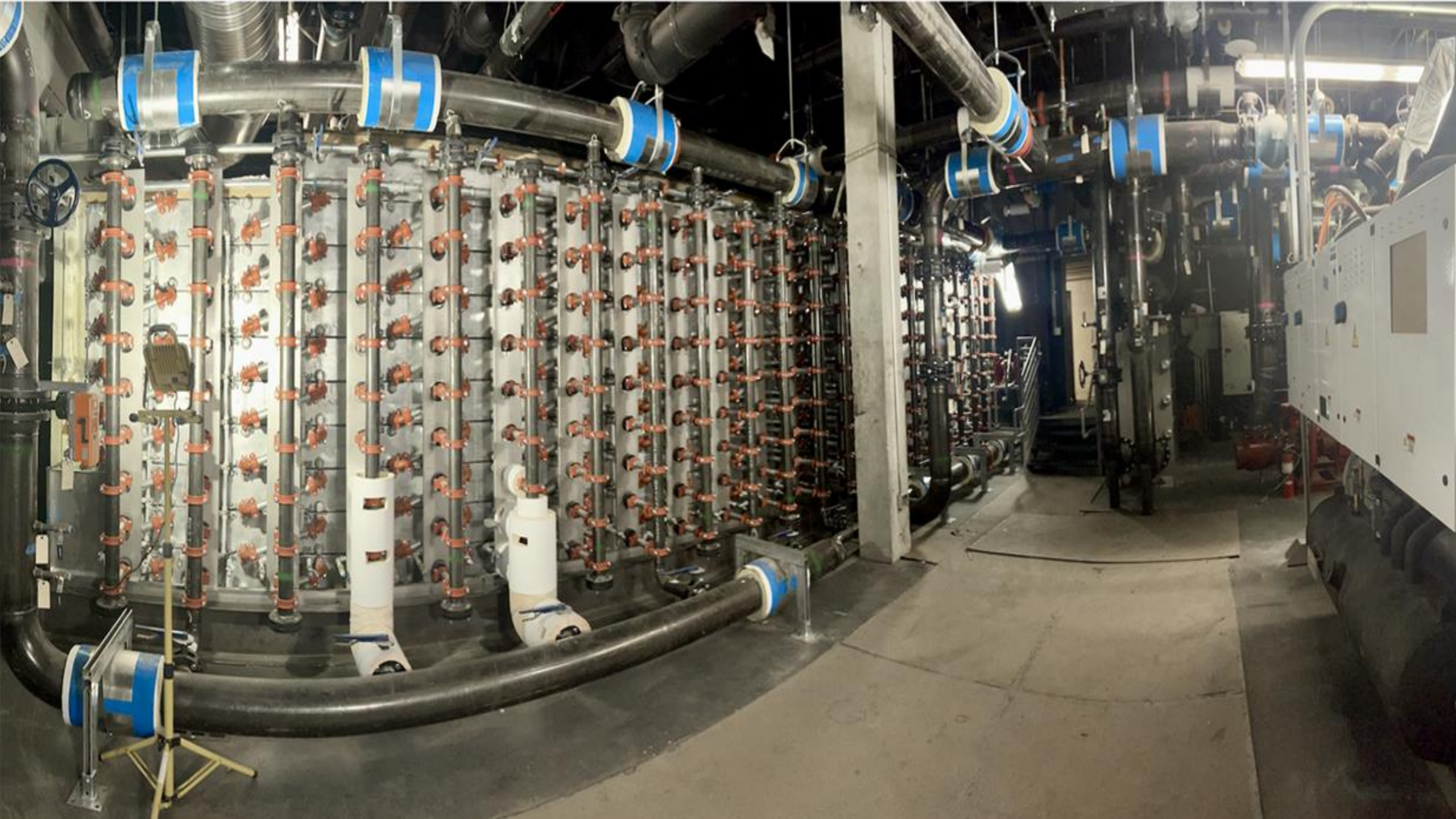

Encapsulated ICE




2A

1.3 MWh System installed at the Beverly Hills and Waldorf Astoria, July 2023

Hilton Beverly Hills System




CONDENSER WATER SUPPLY

August Day - Demonstrated a 256kW Demand Reduction

579kw

\- 323kw

256kw

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Electric Thermal Storage for Space Heating

Al Takle

Steffes

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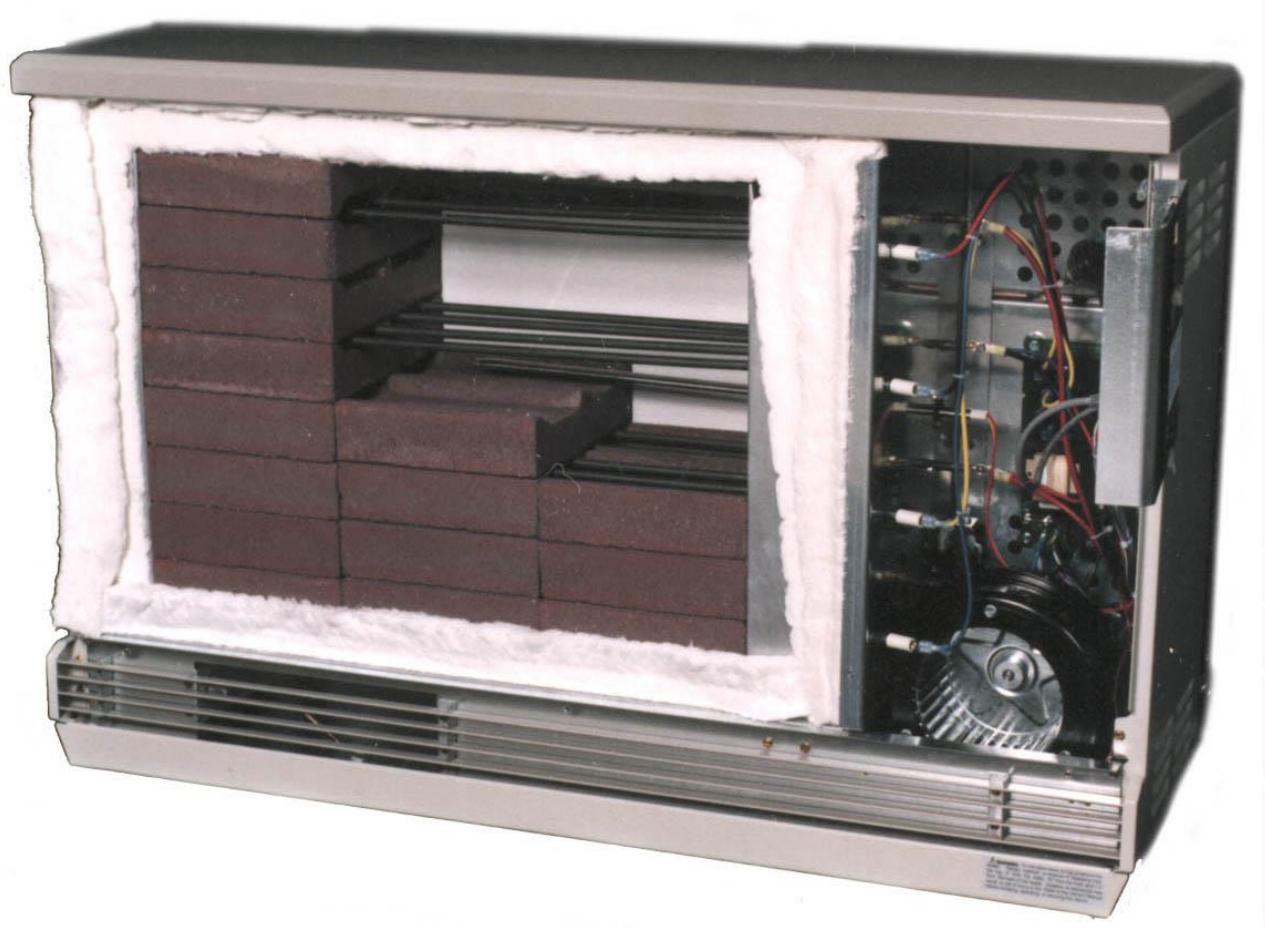
What is Electric Thermal Storage?

Storage of Renewable or Off-Peak Electricity in the Form of Heat



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Is This New Technology?

- Technology started in Europe & Great Britain after WWII
- Came to North America in the early 1970's
- Today, there are hundreds of thousands of systems installed across North America

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Room Units

EZ ZONING

COMFORT

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Residential Hydronic

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Residential Ducted Forced Air

(Transparent View)

- Electricity is stored as heat in a well insulated brick core.
- Combination of heat pumps and Electric Thermal storage maximizes home and the electric grid system efficiency.
- On-board controls regulate charging and discharging.
- Internal blower system delivers the heat to the conditioned space as needed to maintain total home comfort 24/7.

A typical installation

IT'S FULLY AUTOMATIC

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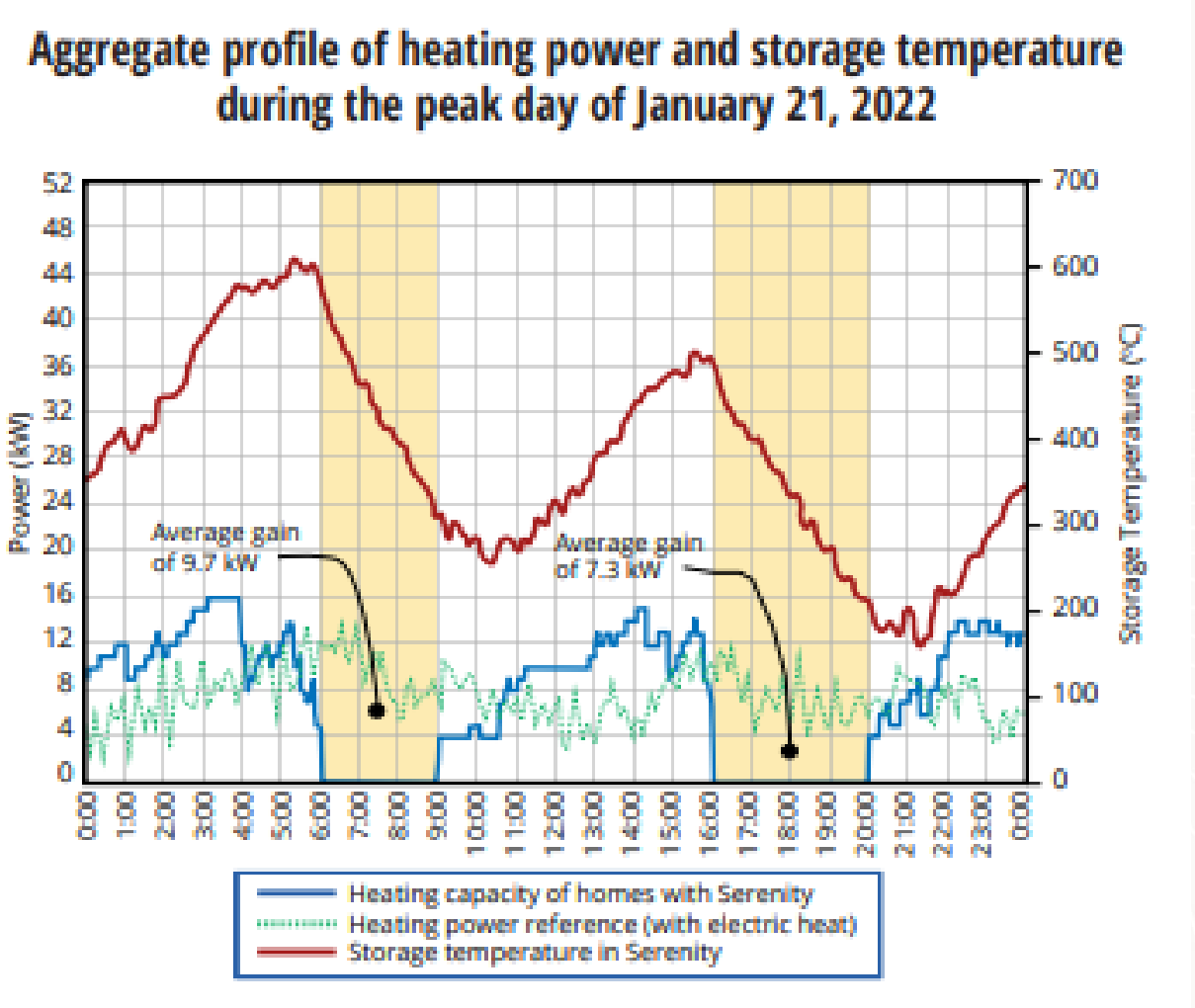
Hydro Quebec Results



Courthouses, Schools, and Historic Buildings

Courthouse = 75 Room Units

Law Enforcement Center = 7 Hydronic Units

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Commercial, Industrial, and Institutional

Hydronic

- Schools have been the primary application
- BACnet compatible
- Increased building load factor

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Microgrid: Off-Grid Wind Integration

Displaces significant amounts of fuel oil for heating homes

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Questions for the Panel?

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Thank you for joining us today!

Please contact Makenzie Horrigan at AHRI for additional information (MHorrigan@ahrinet.org)

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