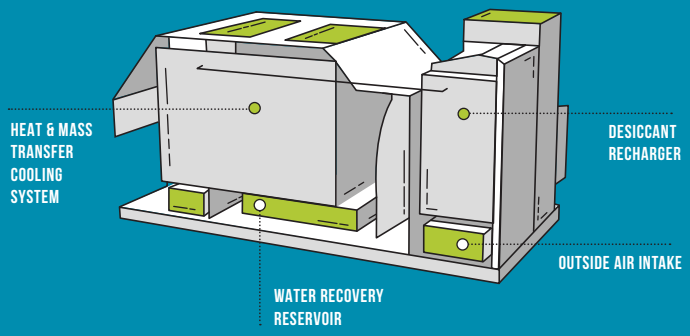
Technology Early Deployment

# Blue Frontier

## Ultra-Efficient, Packaged Rooftop HVAC for Commercial Buildings




Blue Frontier's energy storing, electrically driven, desiccant enhanced evaporative cooling air conditioning system (BF ES/AC) combines two familiar processes: a desiccant, latent-cooling stage, followed by an indirect evaporative cooling stage. This combined process significantly reduces the energy required to generate air conditioning and is suitable for all climates – both dry and humid. The company's patented system is derived from cutting edge NREL research and includes an added component for storing excess renewable energy and/or waste heat in the form of a high concentration salt solution.

### TECHNOLOGY BENEFITS

**60%**
**REDUCTION**
in energy use.

**90%**
**REDUCTION**
in peak electrical demand.

**4-7**
**HOURS**
energy storage cooling capacity.

**85%**
**REDUCTION**
in GWP from refrigerants.

**Disclaimer:** Blue Frontier's smart air conditioning system was chosen for TED because it supports **California's clean energy goals** of increased energy efficiency, reduced GHG emissions, energy storage capacity, and demand flexibility. This document does not constitute or imply endorsement, recommendation, or favoring by EPRI or SCE of the product or company described herein. This publication is funded and administered by Southern California Edison's Emerging Technologies Program.

**TED SPONSORSHIP:**
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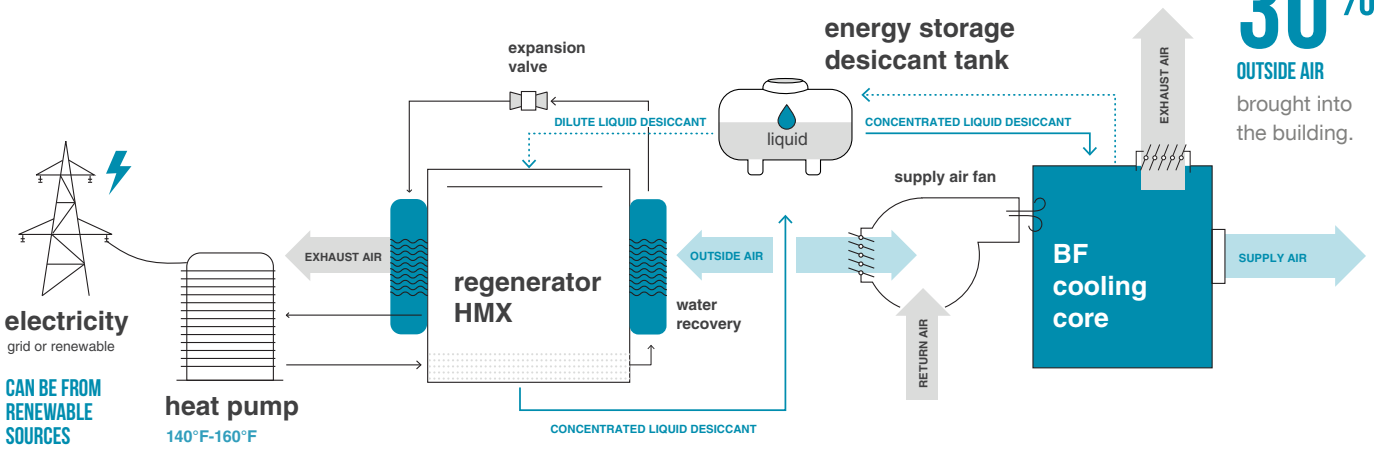
# AC system operation and performance base case

**2X**
**THE ENERGY DENSITY**
of ice.

**energy storage desiccant tank**

**30%**
**OUTSIDE AIR**
brought into the building.




Blue Frontier's core air conditioning/energy storage technology integrates **Desiccant Enhanced Indirect Evaporative Cooling**, thermochemical energy storage and an efficient converter for transforming renewable electricity into heat.

- ✓ Electricity drives a heat pump that generates **140°F to 160°F heat** (efficiency increases as ambient temperature increases).

> Heat is used to **CONCENTRATE A LIQUID DESICCANT,** releasing water that is recovered for later use to drive air conditioning.

- ✓ High concentration liquid desiccant is stored in an **energy storage tank** providing 4-7 hours of near zero energy cooling.
- ✓ When air conditioning is required, high concentration liquid desiccant generates air conditioning by dehumidifying air and then subjecting this low humidity air to **indirect evaporative cooling**.

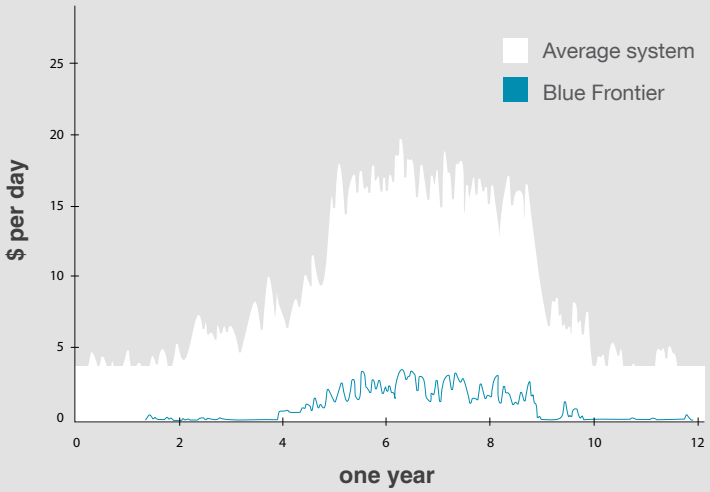
## AC BASE CASE PERFORMANCE REVIEW

Baseline comparison through modeling/analysis tools by Blue Frontier.

### HIGH IMPACT EXAMPLE

Hot and dry environment with a high cooling load.

**Per 5-ton unit A/C electricity cost comparison***




**91%** kWh **ENERGY REDUCTION**
20 MWh annually

**85%** kW **DEMAND REDUCTION**
6 kW Coincident Peak Day

***Note:** Comparison to replace an existing 2020 energy code compliant 5-ton AC condensing unit in the high desert (CZ-15). Includes heat pump kW and kWh for regeneration, does not include blower motor or winter heating energy, which are equivalent to current high efficiency packaged RTU equipment.

## TARGET CUSTOMERS

- Non-residential building owners/operators who require 5 – 10 ton packaged rooftop units and replacement systems.
- New building construction.
- Electric utilities that offer energy efficiency, demand response, and energy storage programs.

## HARDWARE COMPATIBILITY

- Thermochemical medium - non-toxic, non-volatile, non-flammable and very high density.
- Efficient, sustainable and permanently reduces energy and demand charges.
- High-COP air source heat pump regenerator transforms/ stores intermittent solar electricity.
- Load-shift up to 8 hours (50 kWh) of either building solar energy or excess from the grid.
- Unit can be scaled from 1- 50 tons.
- IP covers a platform technology that can be applied as a direct 1-for-1 replacement of existing vapor compression units.

## SYSTEM BENEFITS

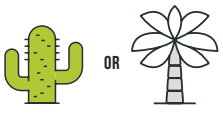
ELECTRIC HVAC


DEMAND FLEXIBILITY

LOW MAINTENANCE

HIGH EFFICIENCY


LOW GWP REFRIGERANT




DRY & HUMID CLIMATES

ENERGY STORAGE

SUPPORTS CA DECARBONIZATION GOALS

DISPATCHABLE DER

CARBON NEUTRAL BY 2045

# California's decarbonization challenge

California's executive order B-55-18 mandates that the state achieve carbon neutrality by 2045. Additional legislation supports this goal through multiple strategies that include double energy savings by 2030 (SB 350), increased demand flexibility (19-OIR-01), advanced energy storage and 100 percent of all retail electricity from renewable energy (SB 100). Applying these strategies to new construction and upgrades to existing buildings provides a path to achieving carbon neutrality but also comes with a new set of challenges:

**1.**

### Supporting the goal

New technologies for buildings must support most or all of the desired outcomes for California.

**2.**

### Testing and codes

Implementation requires extensive testing, compliance with existing codes and standards, utility participation and an enabled workforce.

**3.**

### Replacing the old

Requires replacement of old technologies. The new technologies must meet or exceed expectations for performance and return on investment.

## BLUE FRONTIER SUPPORTS CALIFORNIA'S DECARBONIZATION GOALS

Compared to conventional AC systems, Blue Frontier's ES/AC **reduces energy use by at least 60% (and up to 90%)** and efficiently stores and load-shifts renewable energy, reducing **peak electrical demand by up to 90%**. A 5-Ton system **eliminates ~6 kW of peak electrical demand** and **saves ~10 MWh/year** over conventional AC.

When providing cooling from energy storage, Blue Frontier's EER is 114 @ 105F (33.4 COP, 105 watts/Ton) and when not running on stored energy the EER is 31.4 @ 105F (9.2 COP, 380 watts/Ton). IEER = 38, Energy Storage IEER = 129.

# Market barriers to replacement of old HVAC systems in commercial buildings

A state-wide emphasis on decarbonization of commercial and multifamily buildings supports a large potential market for a technology like Blue Frontier, with the beach-head of opportunity in utility demonstrations (NY & CA) within a serviceable, available market of 2.6 million units/year. The total addressable market for Blue Frontier is 40 million units in the US alone.

**BARRIERS STILL EXIST IN SEVERAL AREAS:**

## Barriers

### FOR EXPANSION

- ✓ Field demonstration data.
- ✓ Utility specific use cases.
- ✓ Lack of brand awareness.

### TO SCALE

- ✓ Manufacturing supply chain.
- ✓ Workforce training.
- ✓ Customer adoption.
- ✓ Development of distribution and service relationships.

**CREATING A PATH TO COMMERCIALIZATION THROUGH THE FOLLOWING ACTIVITIES:**

## Opportunities

### UTILIZE LEVERAGE POINTS

- ✓ Stakeholder supported grants worth >$3M.
- ✓ Collaboration with EPRI .
- ✓ Networking with SCE and other IOUs.
- ✓ Field test in CA.
- ✓ Align with CA Priority Partnership Areas.

### REALIZE COMPANY GOALS

- ✓ Field demonstrations with customers in NE and SW.
- ✓ Expand manufacturing capabilities.
- ✓ Apply for CA CEC EPIC Program funding.
- ✓ Apply to utility RFOs for region-specific field testing and support their demand flexibility strategies.
- ✓ Expand interest across utilities and industry professionals.

# Market readiness

**6-7**
TECHNOLOGY READINESS LEVEL SCORE

- **2021**
  Validate full-scale production-ready design NREL & CalTestBed.
- **2022**
  Utility-sponsored field demonstrations Independent M&V Utility Workpapers.

**2**
YEARS TO MARKET
anticipated
< 4 years maximum

- **2023-2024**
  Limited release of 1,000 units to prove performance and reliability.
- **2024-2025**
  Accelerate market penetration through ESCOs.

  Enter into MW-scale energy storage and NWA utility contracts.

**4**
MANUFACTURER READINESS LEVEL SCORE

- Researching high-volume microporous membranes.
- Fans and liquid desiccant are readily available.
- Contract manufacturing to produce final product.

**3**
KEY OUTCOMES

- **HIGH EFFICIENCY COOLING**
  Up to 90% energy savings.
- **NATIVE ENERGY STORAGE**
  4-7 hours of storage allows for load shed and shift of AC.
- **DEMAND ENERGY**
  Up to 98% peak demand reduction.

# Supporting utility goals for decarbonization

**1.**

### Energy savings

Reduces energy consumption by **>60%.**

**2.**

### Decarbonization

Eliminates 85% GWP refrigerant impact; promotes electrification.

**3.**

### C&S alignment

EER (Energy Efficiency Ratio) is **114 @ 105F**

**4.**

### Demand flexibility

Eliminates **~6 kW** of peak electrical demand, saves **~10 MWh/year.**

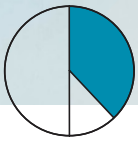
BLUE FRONTIER

# Modeled case studies

% REDUCTION IN

## A/C energy consumption and peak electrical demand*

### Annual reduction in AC energy consumption

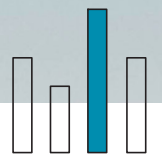


| | SACRAMENTO | PALM SPRINGS | SAN DIEGO | LOS ANGELES |
|---|---|---|---|---|
| Outpatient healthcare | 84% | 91% | 70% | 80% |
| Primary school | 90% | 95% | 69% | 81% |
| Small office | 88% | 92% | 73% | 80% |
| Stand alone retail | 90% | 92% | 52% | 76% |

**81%**
AVERAGE

*Data based on Blue Frontier modeling

### Reduction in peak AC electrical demand



| | SACRAMENTO | PALM SPRINGS | SAN DIEGO | LOS ANGELES |
|---|---|---|---|---|
| Outpatient healthcare | 80% | 85% | 60% | 75% |
| Primary school | 94% | 95% | 85% | 95% |
| Small office | 95% | 89% | 88% | 88% |
| Stand alone retail | 95% | 90% | 94% | 89% |

**87%**
AVERAGE

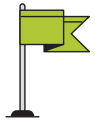
# Blue Frontier Utility Opportunity Assessment

TECHNOLOGY CATEGORY

## HVAC

BF ES/AC:

Non-Vapor Compression, Liquid Desiccant AC, with Thermochemical Energy Storage, & Smart Controls.



ETP PRIORITIES

### ENERGY SAVINGS

Reduces consumption by > 60%.

### DECARBONIZATION

Eliminates the GWP impact of refrigerants by 85%; promotes electrification demand for electricity is tied to renewable energy generation.

### C&S ALIGNMENT

EER is 114 @ 105F

### DEMAND FLEXIBILITY

Eliminates ~6 kW of peak electrical demand, saves ~10 MWh/year.

KNOWLEDGE INDEXES

### TECHNICAL PERFORMANCE

Medium

### MARKET KNOWLEDGE

Medium

### PROGRAM INTERVENTION

Medium

### UTILITY VALUE

- Energy Savings per Unit:10 MWh/yr over conventional AC.
- Demand Savings per Unit:~6kW of peak demand.

### UTILITY TRAJECTORY

- EE Operations (Energy Efficiency).
- Integrated DSM (Storage).
- Building Electrification.

OPPORTUNITIES

### CRITICAL ETP ACTIONS

- Socialize within SCE.
- Socialize with other IOUs.
- Field test in CA.

### LEVERAGE POINTS

- NYSERDA Grant.
- ORNL & DOE support.
- CA Priority Partnership Areas.
- EPRI.

### GAPS TO FILL

- Field demo data
- Utility specific use-case

### MARKET SIZE

- Beach-head: Utility Demos (NY & California).
- SAM: 2.6 million units/yr.
- TAM: 40 million units in US alone.

BARRIERS

### IN-PROGRESS

- Field demo data.
- Brand awareness.
- Manufacturing scaling.

### UPCOMING

- Customer adoption.
- Workforce training.
- Manufacturing supply chain.
- Development of distribution & service relationships.

### SOLUTION

- Utility agreement for HVAC as a service.
- Commercial availability.

NEXT STEPS

### COMPANY

- Expanded manufacturing capability.
- Utility-specific cost-benefit analysis.

### UTILITY

- Field demo results.
- Value proposition and business use case.

### OTHER

- EPRI M&V testing and/or grant collaborator.
- Partnerships with developers, HVAC contractors, Building Energy Management Systems .

ted

TED is a process where innovative technologies are selected for assessment and review based on the technology application, team strength, and alignment with the Technology Priority Maps, to fulfill the California decarbonization challenge.


### FOR MORE INFORMATION

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