Better Buildings
U.S. DEPARTMENT OF ENERGY

SNAPchat: On the Effects of Refrigerant Phase-Outs

Better Buildings Summit

May 17, 2017

U.S. DEPARTMENT OF ENERGY

Agenda

- **Overview of Better Buildings Alliance Refrigeration Team** (Justin Elszasz)
- **Introduction to SNAPchat** (Justin Elszasz)
- **The Target Perspective** (Cara Bastoni)
- **The Starbucks Perspective** (Patrick Leonard)
- **Wrap Up** (Justin Elszasz)

Overview of Better Buildings Alliance Refrigeration Team Activities

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Refrigeration Team Technology Focus

DOE's 2016 High Impact Technology (HIT) analysis identified **alternative refrigerants** as a priority technology for commercial refrigeration.

- March 1, 2017 quarterly call hosted North American Sustainable Refrigeration Council (NASRC)
- Seeking partners for case studies on topic

NORTH AMERICAN SUSTAINABLE REFRIGERATION COUNCIL

Previous HITs included **open display case retrofits** and **case controllers**.

Refrigeration Team Resources

Latest Case Study: Adaptive Controller

- CKE Restaurants (Carl's Jr.)
- Reduced energy use from defrost heaters and evaporator fan
- Energy savings of 10-30%

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Carl's Jr. Installs Demand-Based Defrost Controller

CASE STUDY

Freezers and Coolers Bring Energy Cost Savings to CKE Restaurants

With more than 3,300 restaurants in 42 states and in 28 countries, CKE Restaurants, Inc. owns, operates, and franchises some of the most popular brands in the quick-service restaurant industry, including Carl's Jr.®, Hardee's®, Green Burrito®, and Red Burrito®. The business is committed to environmental responsibility, and is dedicated to reducing its energy consumption.

To advance its commitment to cutting energy waste, CKE, in collaboration with Southern California Edison's (SCE) New Products Development and Launch (NPDL) organization, field tested an advanced demand defrost control system for walk-in coolers and freezers in their Carl's Jr. restaurants.

"CKE is very committed to the long-term sustainability of our environment, wherever economically feasible."

—Juliann Rogers, Director of Energy, CKE

Energy Savings: Technology That Makes it Possible

Energy savings were 30% for the cooler and 11% for the freezer, which represent savings of 2.86 kWh/day and 7.18 kWh/day, respectively. (See Table 1)

A conventional defrost controller operates the defrost heaters on a fixed schedule and terminates defrost when the coil reaches a set temperature. Defrost scheduling is used to prevent excessive frost build-up under worst-case conditions.

However, for many applications, this simplistic defrost scheduling exceeds the actual heat necessary to melt the accumulated volume of frost. The demand defrost control system instead adjusts the defrost cycle to the amount of frost that has accumulated. The controller first checks operating efficiency based on coil and air temperature, and then starts the defrost cycle only when the efficiency drops below a pre-determined point. The controller modulates defrost heater operation to avoid hotspots (which contribute to fogging and icing) and terminates the defrost cycle based on coil and air temperatures. This results in fewer and shorter defrost cycles, which manifests as reduced energy consumption compared to conventional control of resistance defrost heaters.

A Carl's Jr. restaurant (photograph courtesy of CKE Restaurants).

PROJECT SNAPSHOT

- The field test showed 11% to 30% reductions in walk-in energy consumption
- Reduced daily defrost cycles from 4 to 3 (typically)
- Retrofit with the demand defrost control system is technologically feasible and can provide encouraging financial paybacks
- More uniform walk-in temperatures help protect temperature-sensitive products

Table 1. Total Energy Savings for Walk-in Coolers and Freezers

	Cooler	Freezer
Savings Percentage (%)	30	11
Savings (kWh/day)	2.9	7.2
Savings (kWh/year)	1045	2622
Savings ($/year @ $0.15/kWh)	157	393

Learn more at betterbuildingssolutioncenter.energy.gov

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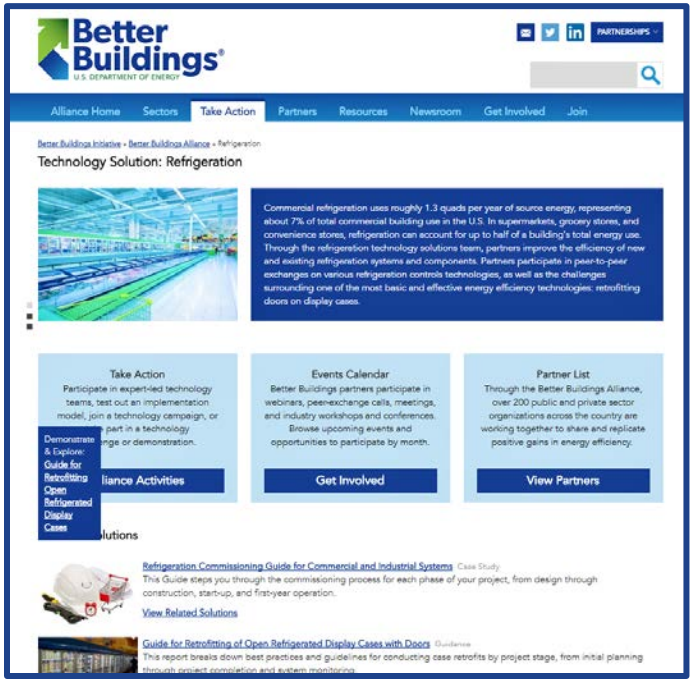
For more information, visit:

https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/CKE Restaurants Case Study on Demand-Based Defrost Controller.pdf

Refrigeration Team Resources

Upcoming: Refrigeration Toolkit

- Centralize resources
- Organize team resources by system component, resource type (calculators, design guides, case studies, etc.)
- Expect debut after Summit



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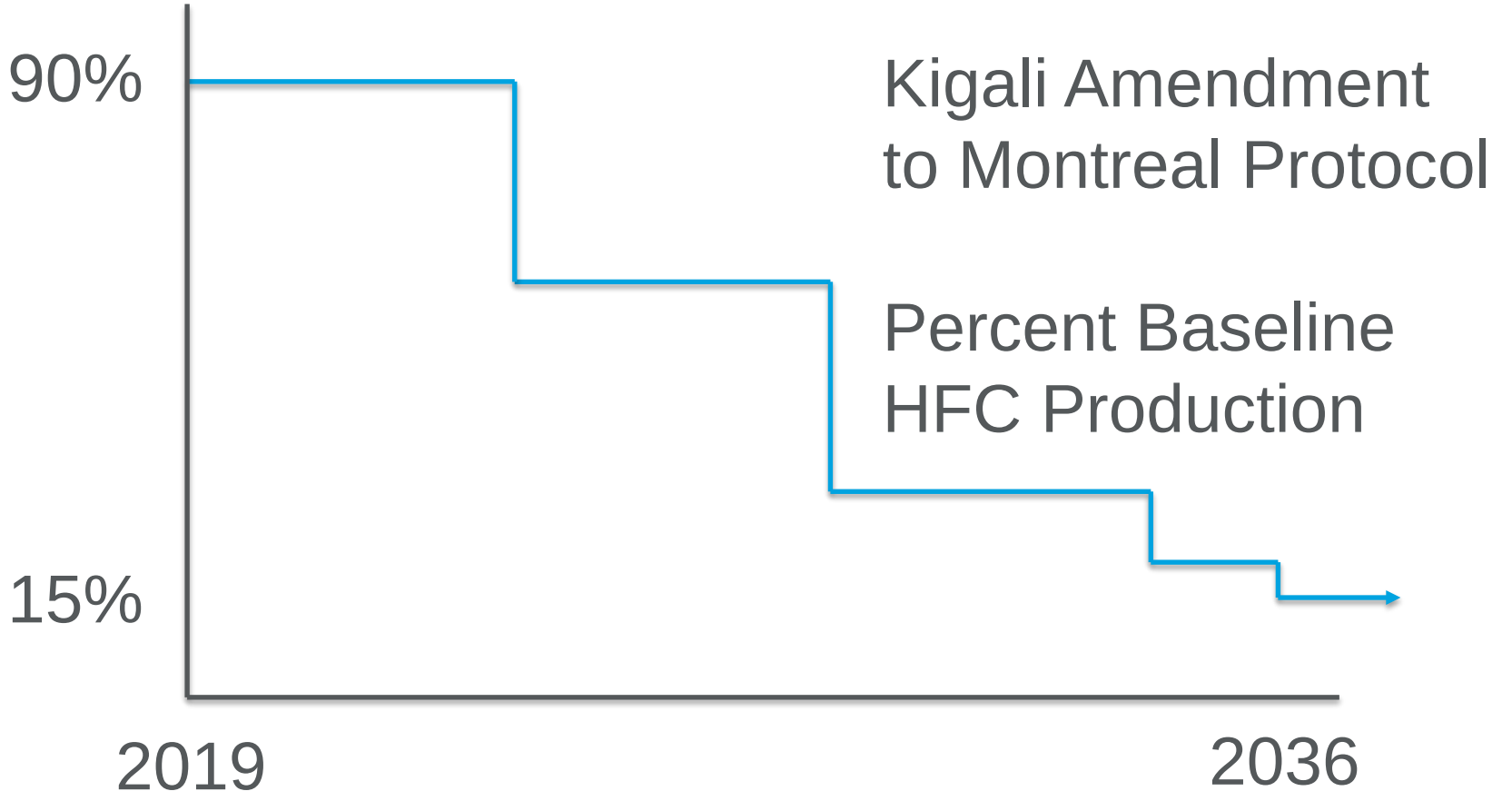
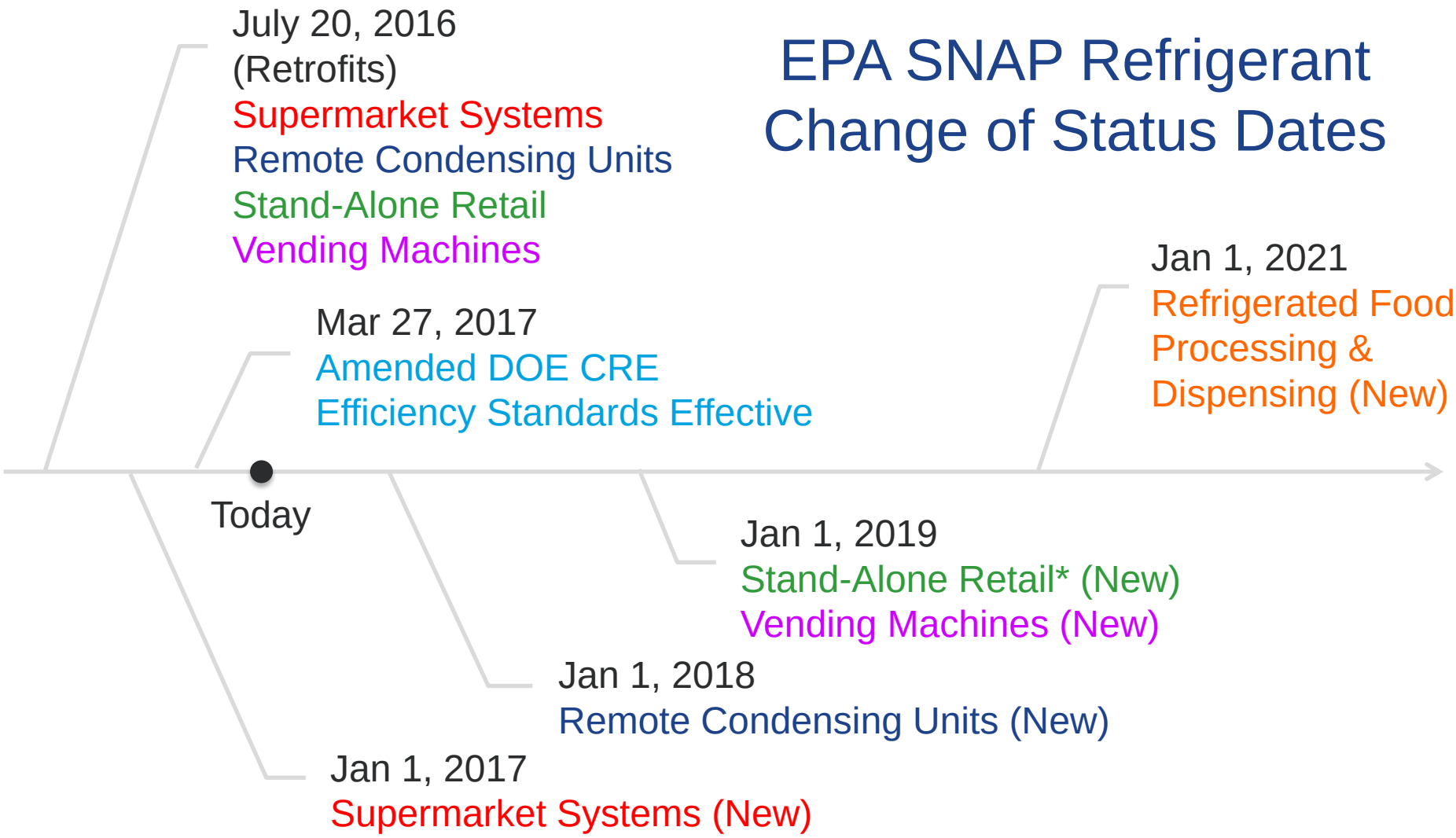
Changing Refrigeration World



Source: http://www.unep.fr/ozonaction/information/mmcfiles/7809-e-Factsheet_Kigali_Amendment_to_MP.pdf

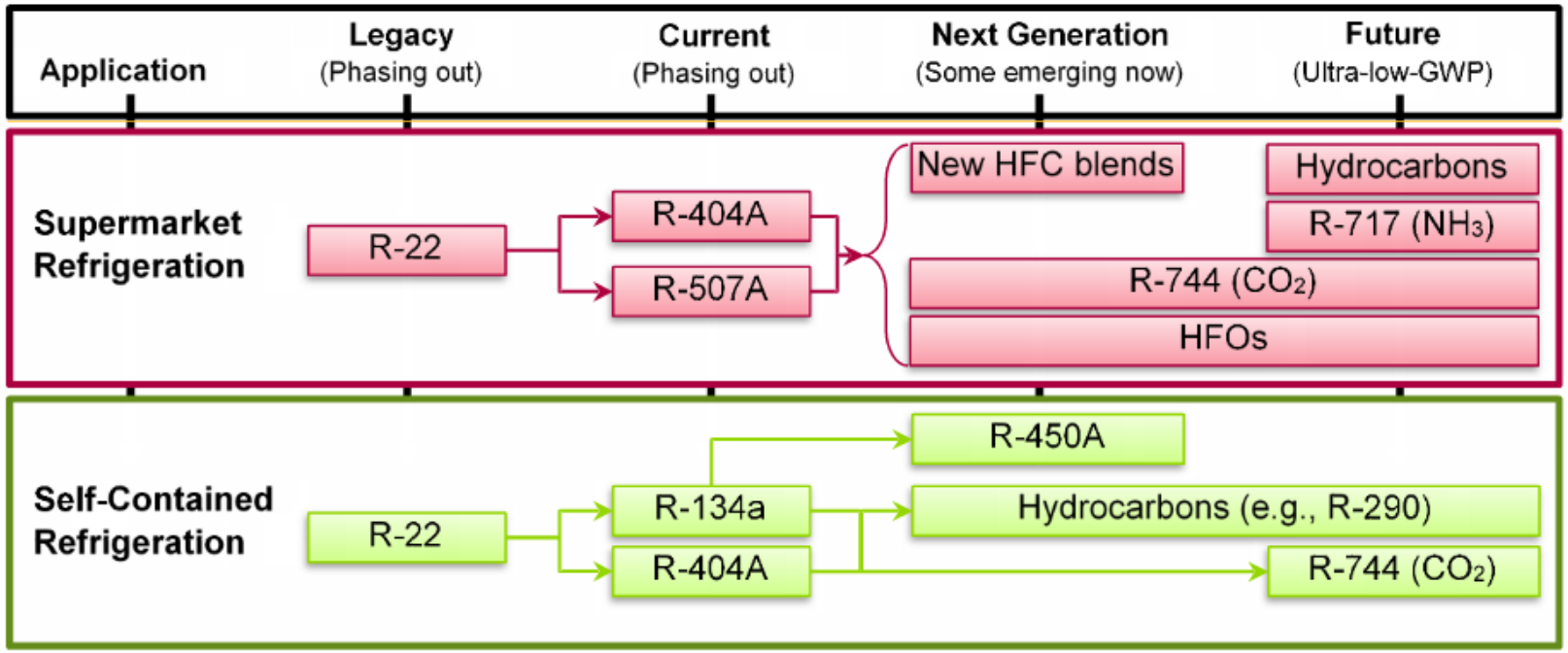
EPA SNAP Refrigerant Change of Status Dates



*Jan 1, 2020 for some Stand-Alone Units depending on temperature and capacity.

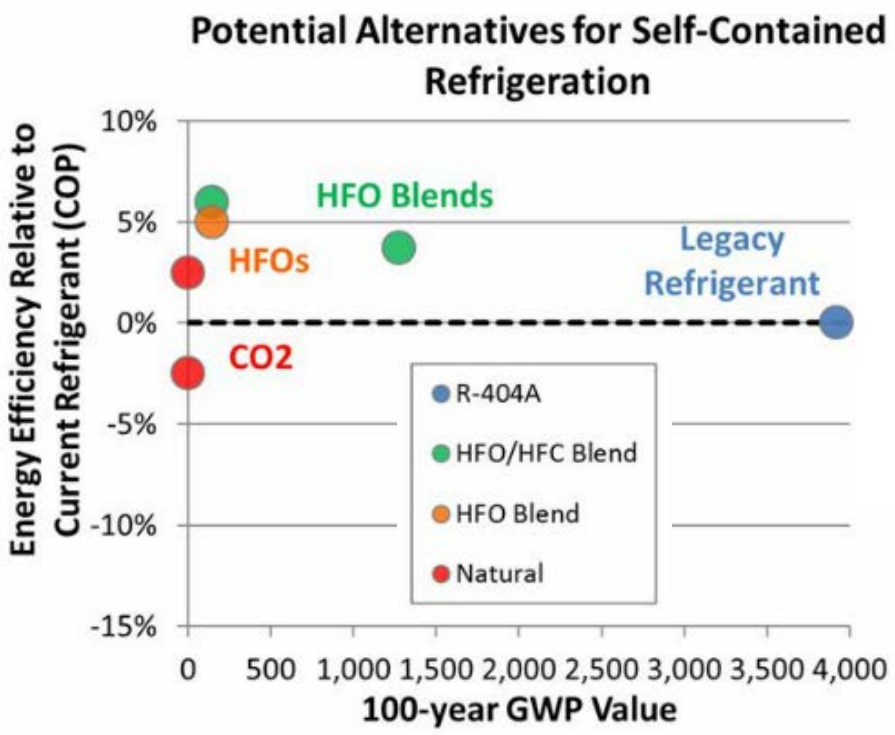
Source: https://www.epa.gov/sites/production/files/2016-12/documents/international_transitioning_to_low-gwp_alternatives_in_commercial_refrigeration.pdf

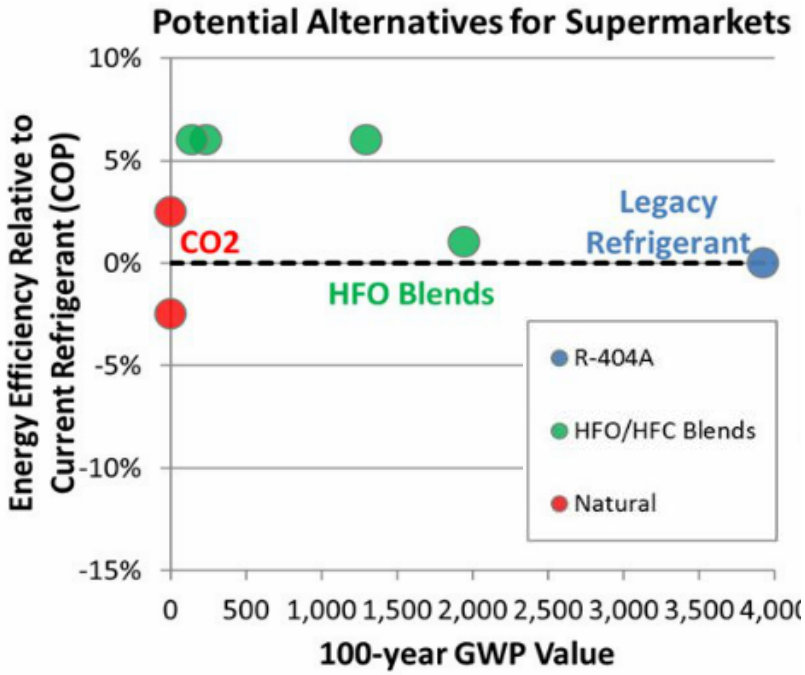
Paths Forward



Adapted from BSRIA presentation found at:
https://www.bsria.co.uk/download/asset/16th-feb-webinar-presentation-gambi.pdf

Refrigerant Performance





Data culled from various reports and product literature. Sources available upon request.

The Target Perspective
Cara Bastoni

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SNAPchat: Effects of Refrigerant Phaseouts

Cara Bastoni, Director of Engineering

May 17, 2017

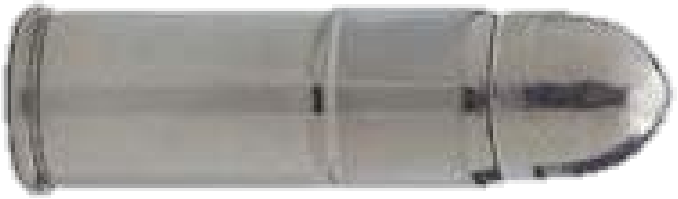
TARGET

- 1,800+ Stores in the United States
- 38 Distribution Centers
- 323,000 Team Members World Wide
- Target.com

CHALLENGES

- Regulatory Requirements
- Energy vs. Global Warming Potential
- Definition of “Low GWP”
- Technical Capabilities

Be Adaptable



There is no silver bullet!

The solution depends on what you're trying to solve for.

Refrigerant Strategy

R22
- Banned 2010

R404A
- Banned July 2016 (retrofit)
- Banned January 2017 (new systems)

R134a
- SNAP delisted 2019 (select applications)
- California HFC phase-down

New refrigerants
- **R290 (Hydrocarbon)**
- **R744 (CO_2)**
- **HFO-Blends**
- **Ammonia**

Options

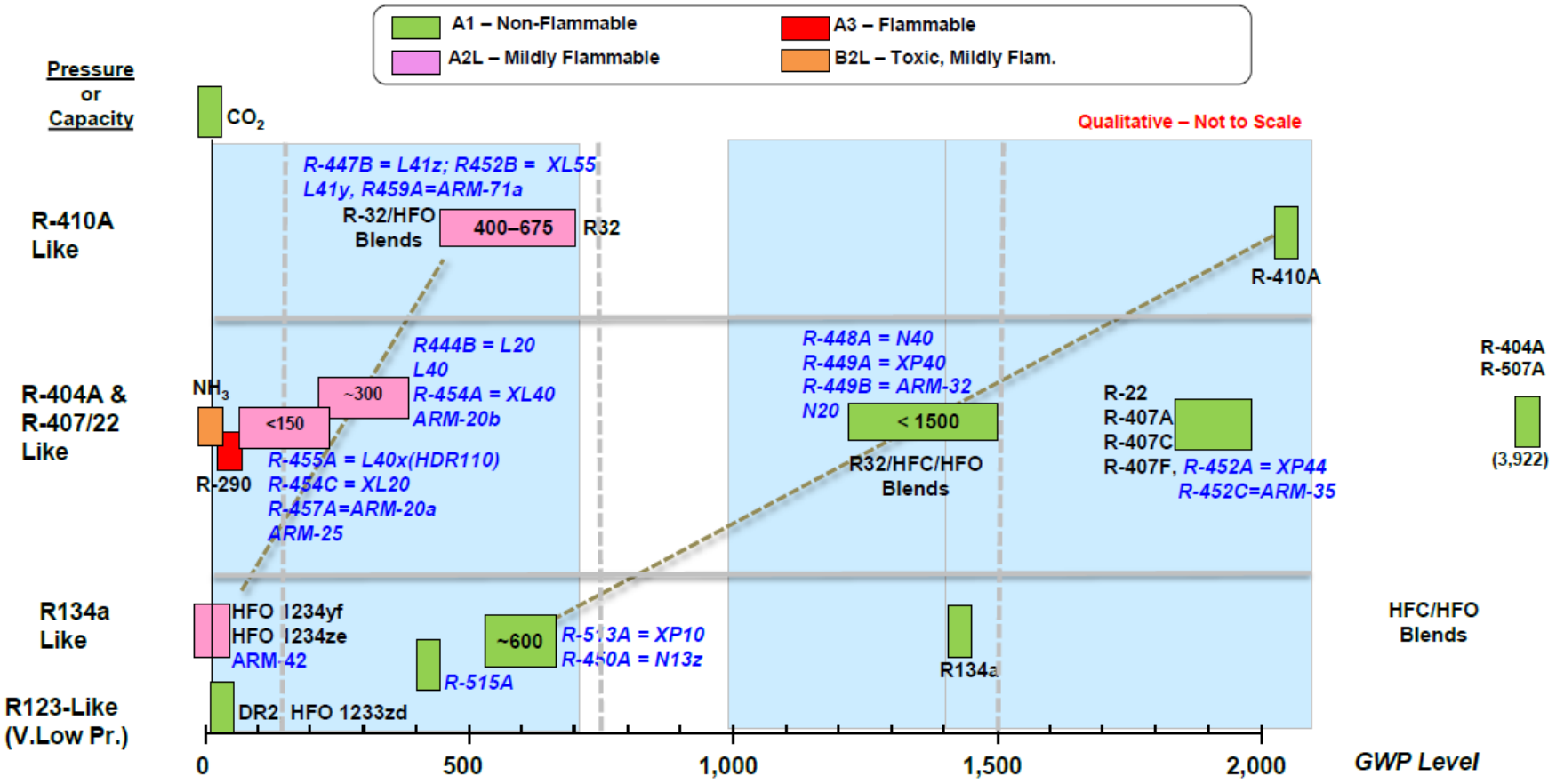
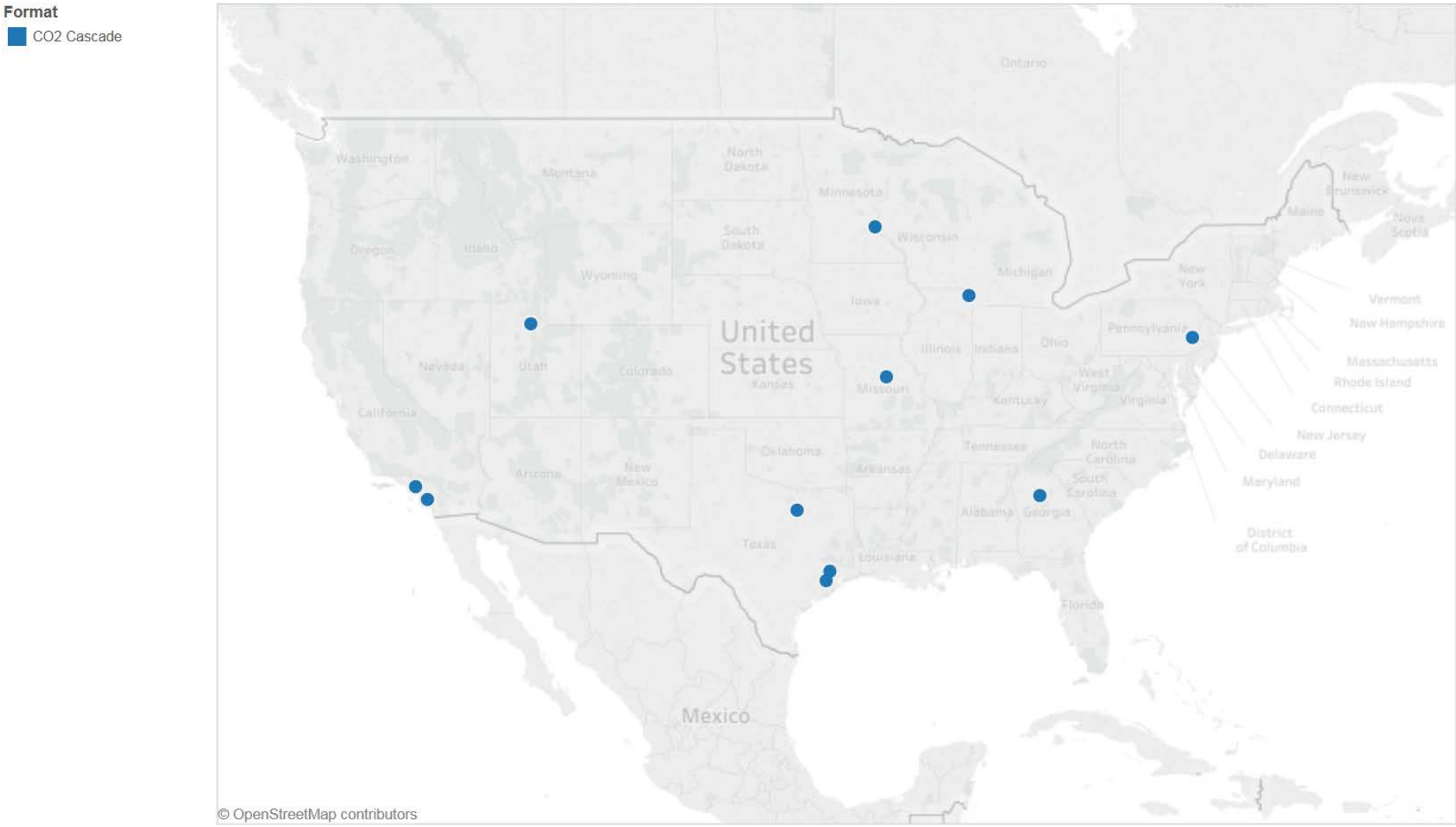


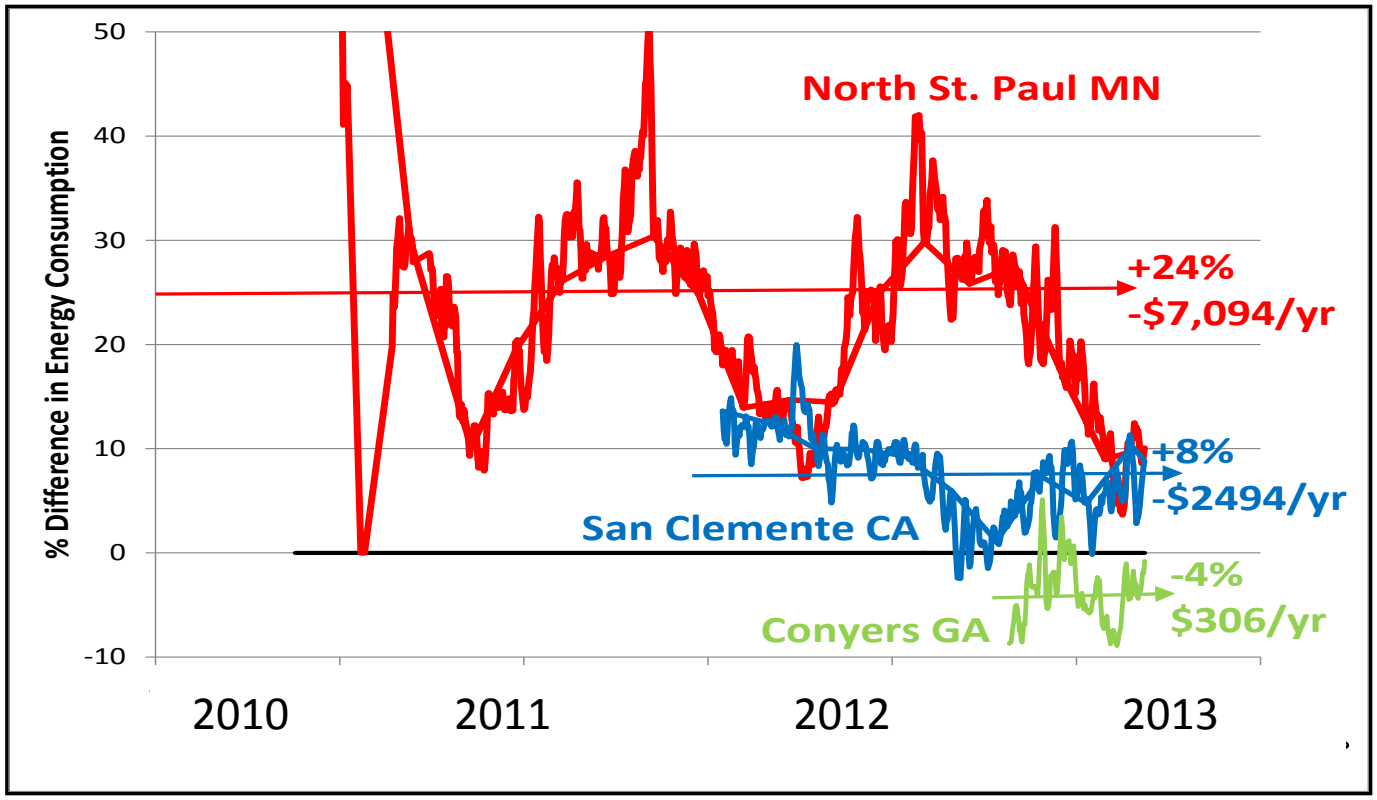
Chart courtesy of Emerson Climate Technologies

CO_2 Cascade Systems

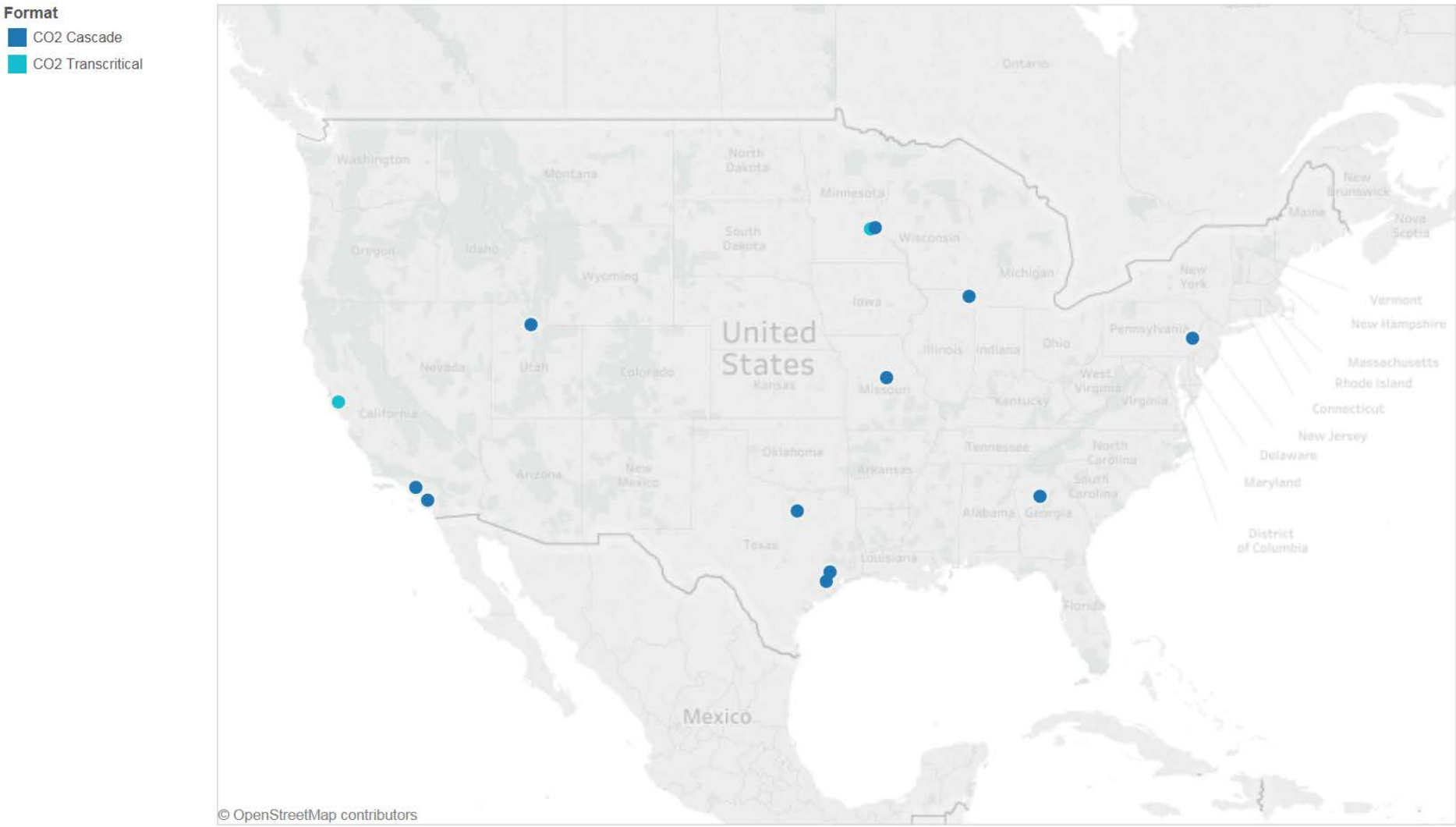


CO_2 Cascade Systems

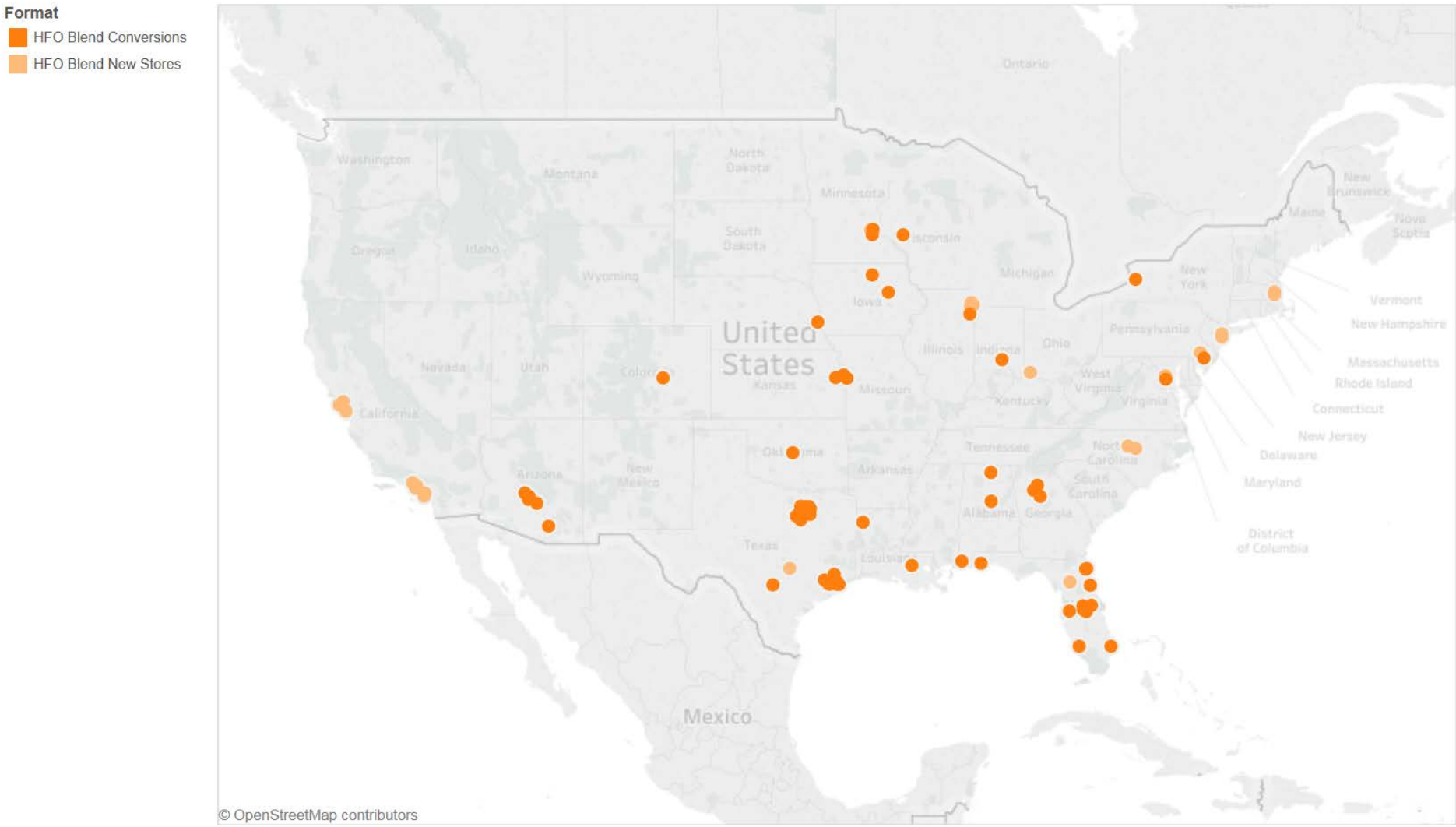
Energy Progression



CO_2 Transcritical Systems

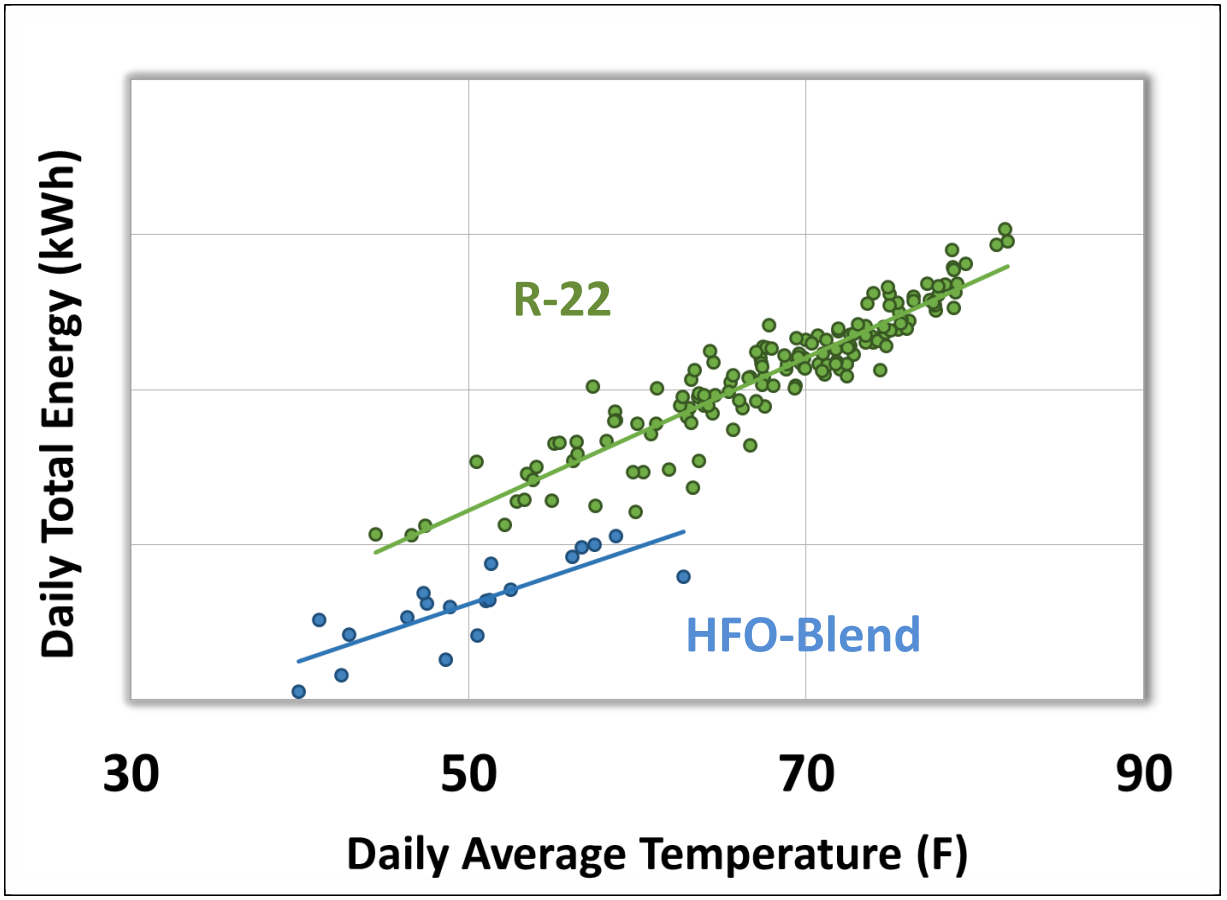


HFO-Blend Stores

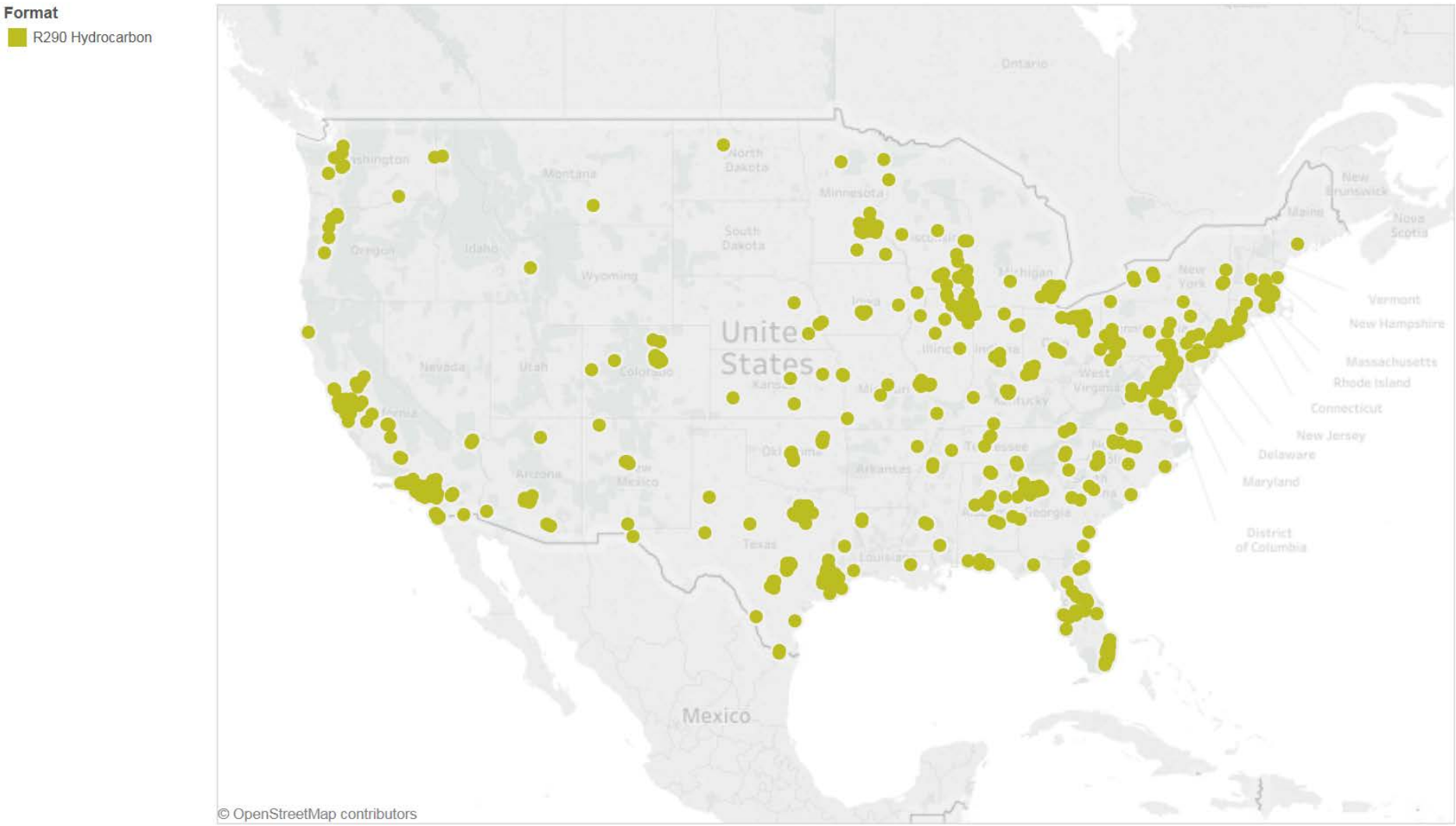


HFO-Blend Stores

Energy Comparison



R290 Hydrocarbon Stores

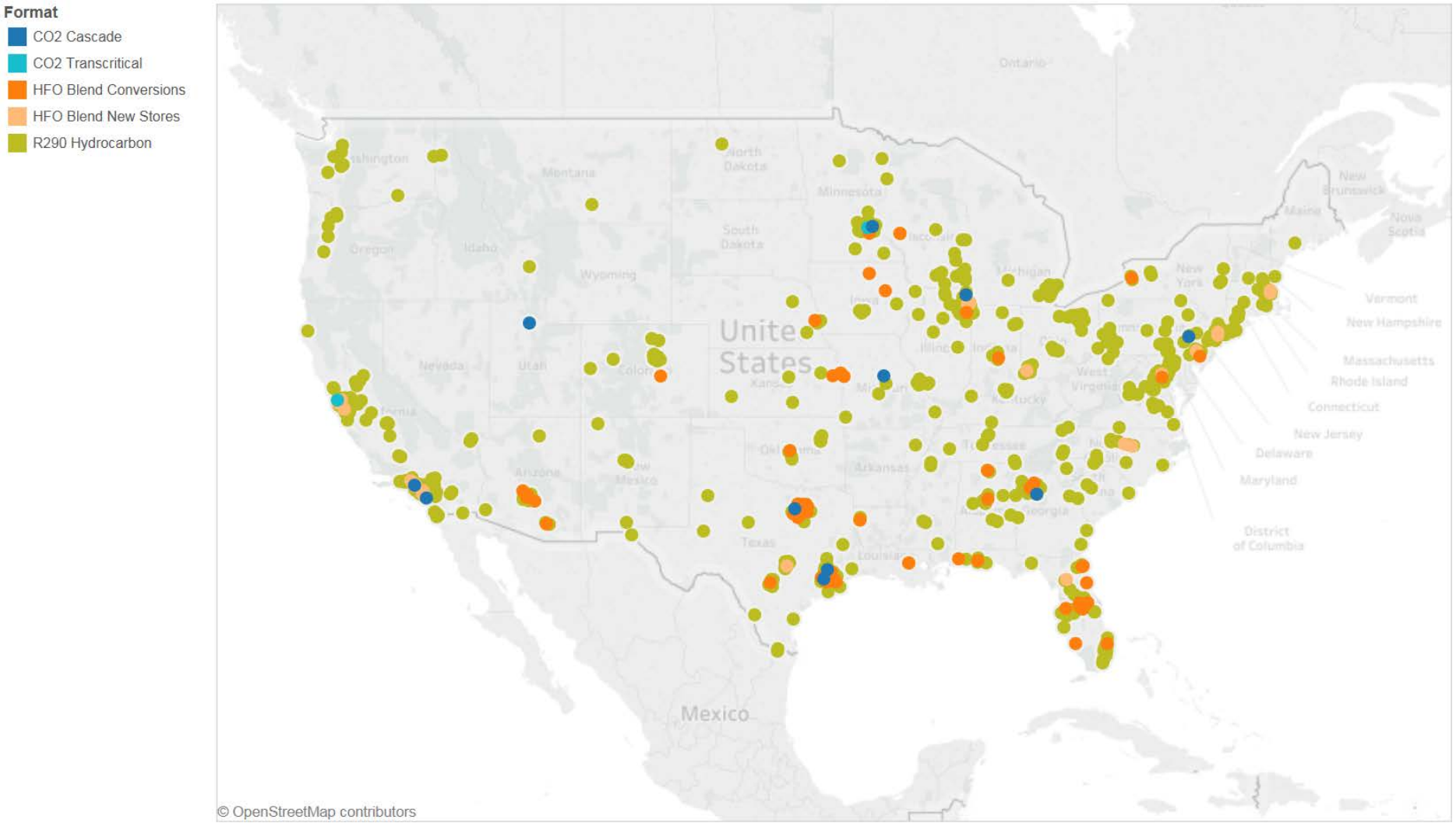


R290 Hydrocarbon Stores

Beverage Cooler Test	R134a	R744 (CO_2)	R290 (propane)
Power (kW)	0.092	0.069	0.043
Annual cost (@$.10/kW-Hr)	$ 80.59	$ 60.44	$ 37.67
Average Case Temp (°F)	40.4	39.9	39.7
Energy Savings	**Baseline**	**25%**	**53%**

R290 is the clear energy leader!

All Alternative Refrigerants



Next Steps

- Continue SuperTarget conversion strategy
- Continue New Store strategy
  - CO_2 Cascade for Prototype
  - HFO-Blend Self-Contained for small formats
- Work with industry partners to increase hydrocarbon charge limits
- Evaluate effectiveness of CO_2 Transcritical systems for future use
- Continue to evaluate new refrigerants and technologies

The Starbucks Perspective
Patrick Leonard

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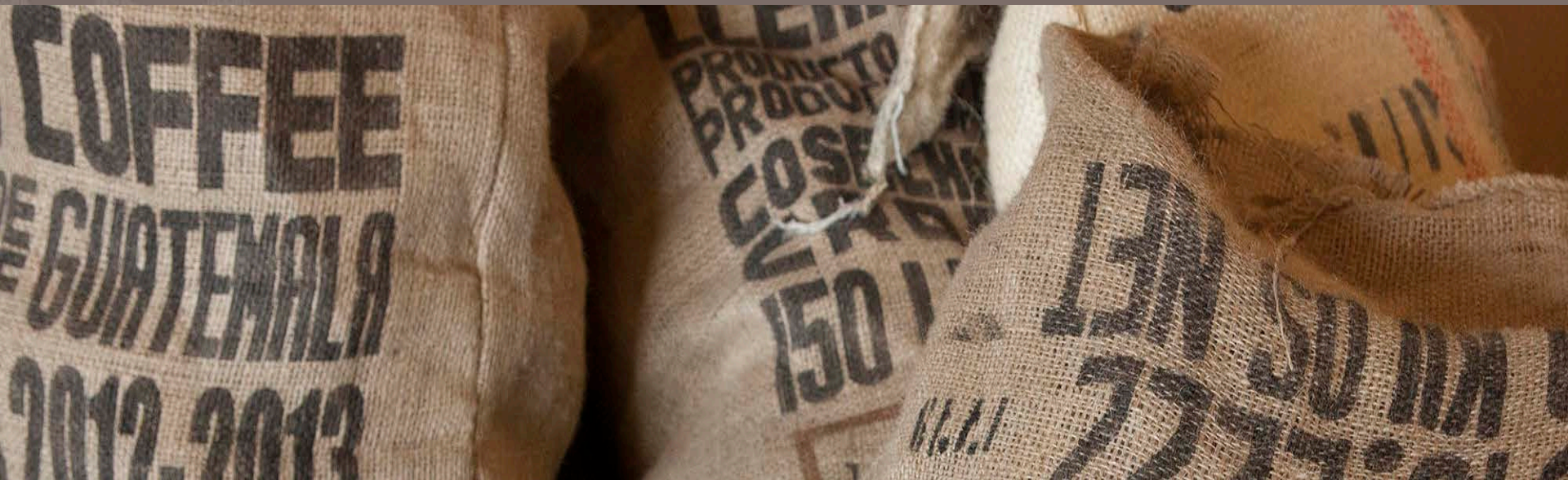
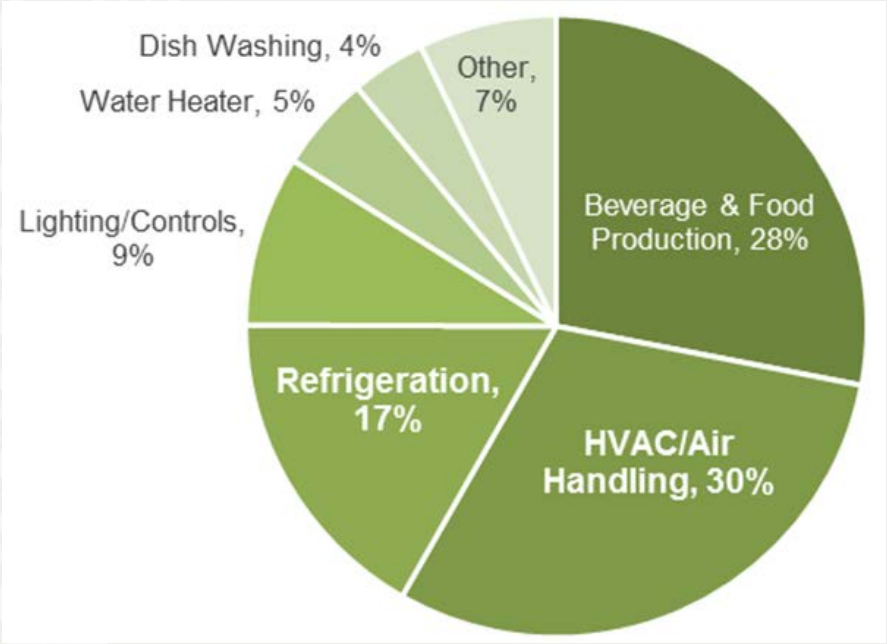
STARBUCKS EXPERIENCE WITH NATURAL REFRIGERANTS



Starbucks is demonstrating green retail leadership by accelerating adoption of R-290 refrigeration in our stores

- non-ozone depleting and very low global warming potential
- tested and approved for safe use in the US
- identified attractive energy savings per R-290 refrigerator against current Starbucks standards
- 2019 DOE standards offer potential for significant energy savings across the retail sector

ENERGY ANALYSIS



Power monitoring store average energy use

- Initial lab testing in Seattle showed savings
- Validated performance in different climates and store formats
- Energy performance was benchmarked against average of stores factoring mixed ages of existing equipment
- Data indicates opportunity for energy reduction ~20% per unit, highest for 2 door freezers and refrigerators

DRIVERS

- Initially - *Constraint*
  - Manufacturer adopting SNAP requirements proactively
  - Phase out of existing product line (R-134a)
- Now - *Opportunity*
  - New standard equipment
  - Energy cost benefits

APPROACH

- Cross functional steering committee & working group to evaluate change
- Lab testing
- Store tests
  - Energy & ambient temperature monitoring
  - Stores in multiple climates
  - Store partner feedback
- Evaluated gaps in service tools and procedures with manufacturers & service suppliers
- Communicate, communicate, communicate
- Phased transition

LESSONS LEARNED

- Same fit and form as current freezers and refrigerators
- No change to food handling performance
- Significant energy benefit
- Limited first cost implication
- Not all service suppliers used to R-290
  - Manufacturer-led training with service network including handing and process changes

Discussion

- What specific steps is your organization taking when designing systems or selecting equipment in light of refrigerant phase-outs?
- Are there resources (design guides, best practices, case studies, etc.) you have found particularly helpful in navigating the refrigerant phase-outs?
- Do you have data or information you'd be willing to share with BBA partners (potentially through developing a new resource)?

Thank you!

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Thank You

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