THE GREENCHILL PARTNERSHIP

Supermarket Experiences Managing Refrigeration Systems in Small-Format Stores

December 5, 2017

Today's Host

Tom Land
U.S. Environmental Protection Agency
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Tom has worked to protect the earth's ozone layer and fight climate change for almost 20 years in the EPA's Office of Atmospheric Programs. He is now running the GreenChill Partnership program to help the supermarket industry reduce emissions of ozone-depleting substances and greenhouse gases.

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- Raise your hand during Q & A
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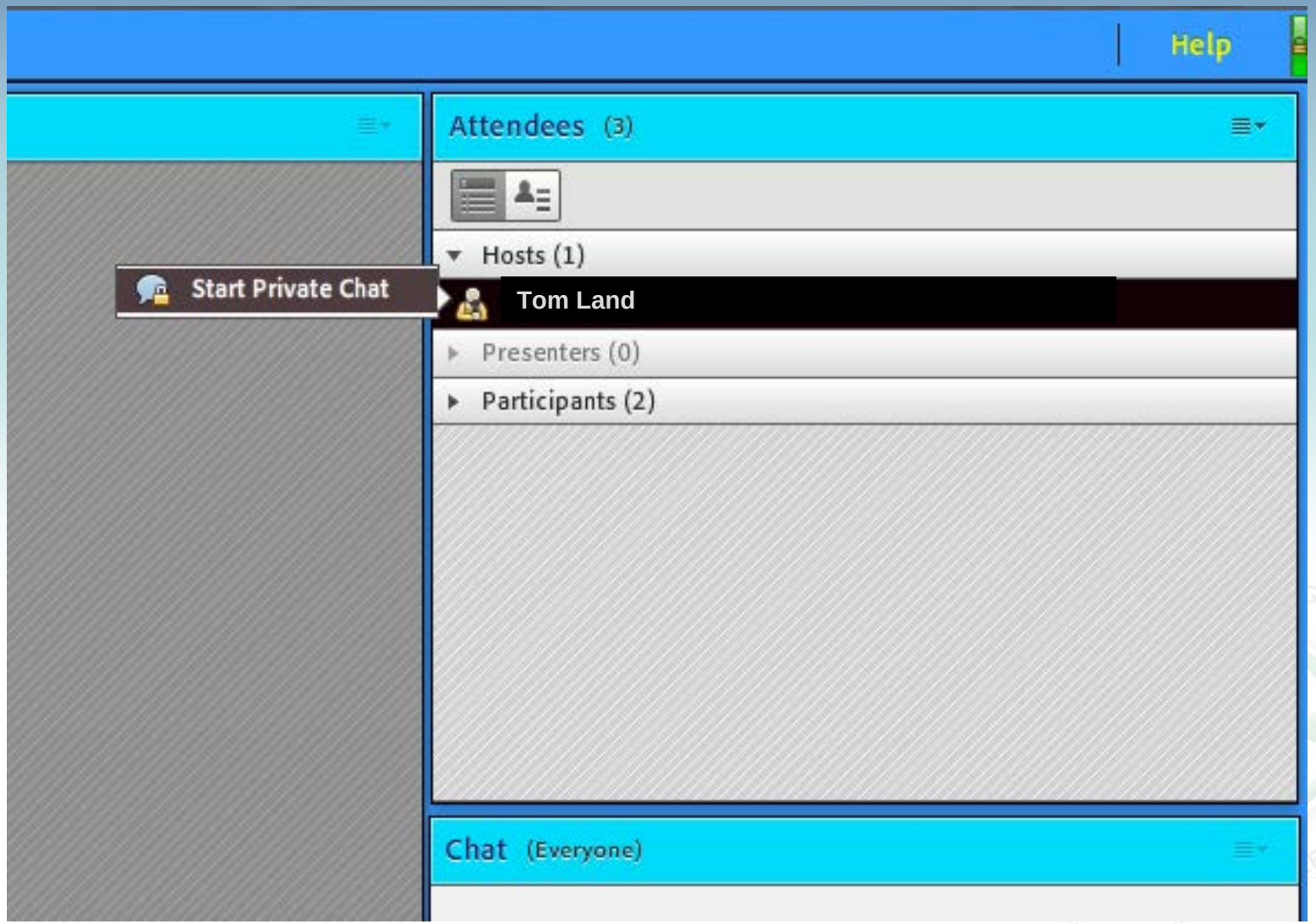

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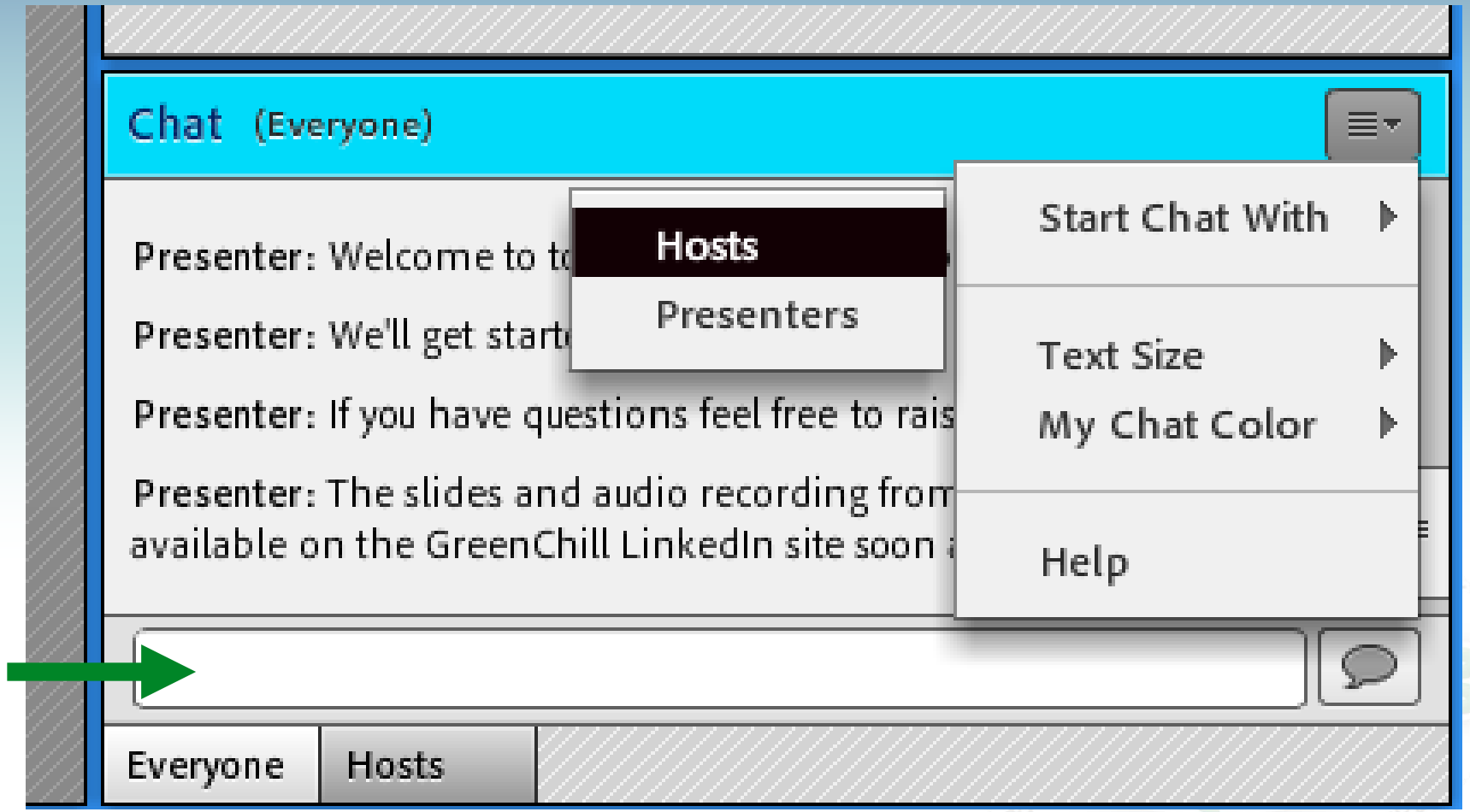

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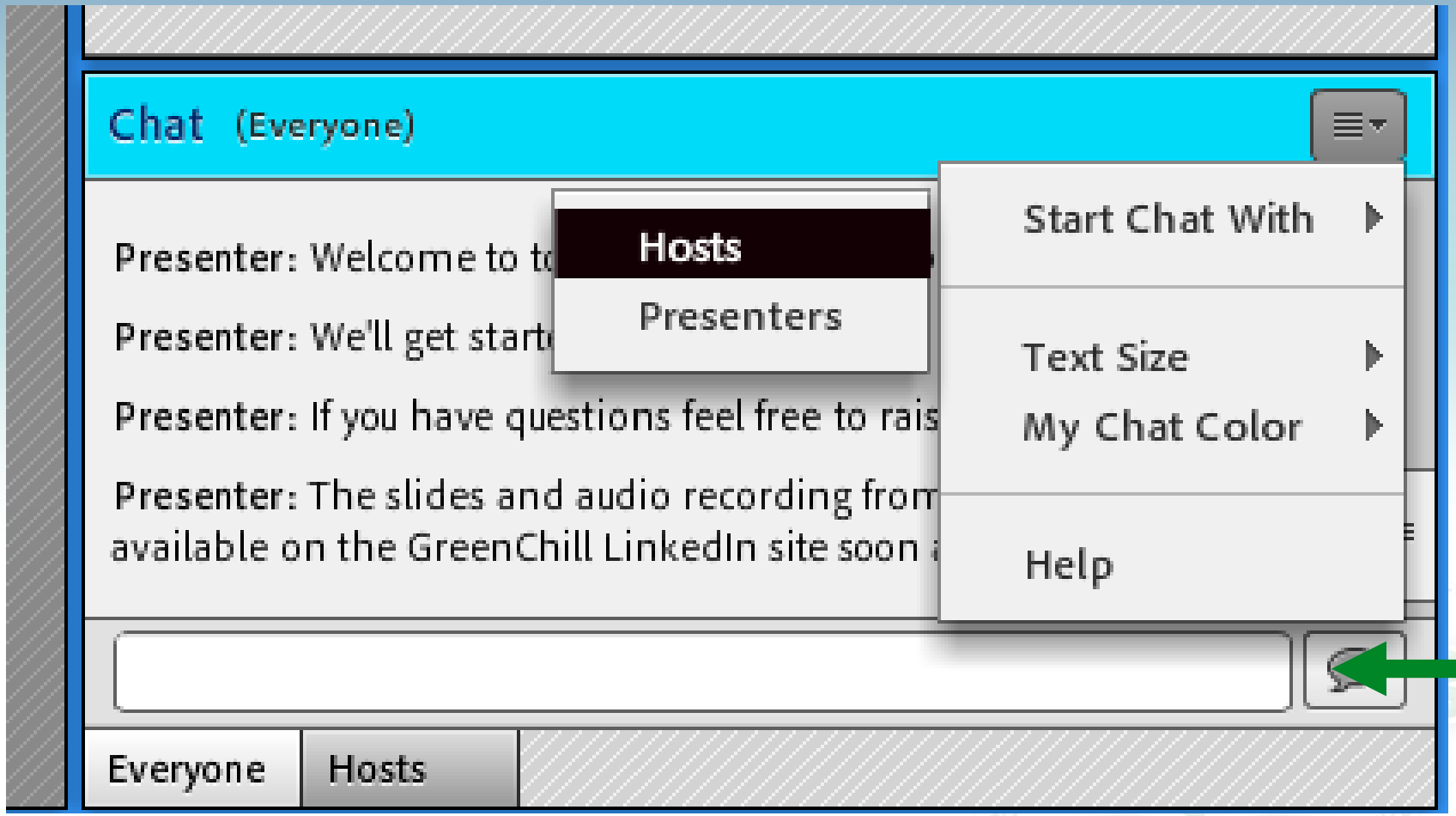

Raising Your Hand

Today’s speaker…

Derek Gosselin

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Derek has more than 30 years of heating, ventilation, air conditioning, and refrigeration industry experience and currently serves as Manager of Hillphoenix's Technical Product Support group supporting the development and application of all products and the advancement of new technologies. Hillphoenix, a Dover Company, is located in Conyers, GA.

THE GREENCHILL PARTNERSHIP

Supermarket Experiences Managing Refrigeration Systems in Small-Format Stores

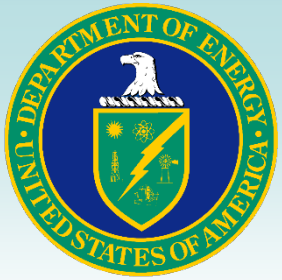
Today's Agenda

Small format retail stores move to implementing carbon dioxide (CO_2) technology

- Regulatory impact in the decision making process
- Natural refrigerants and CO_2
- Overcoming the challenges of moving to new technology
- Understanding total cost of ownership (TCO) and return on investment (ROI)
- Growth of CO_2 installation and our impact on the environment

Regulatory Impact on the Decision Making Process

One of our original goals was to develop a long term refrigerant management program to get out in front of the regulatory impact at both the State and National levels that will provide us a long term solution



Regulatory Impact on the Decision Making Process

California Air Resources Board (CARB) Rules Making Process: Updated October 24, 2017

- Stationary Refrigeration Measures in 2021
  - Refrigerants ≥150 global warming potential (GWP) prohibited new systems ≥ 50 lbs.
  - Refrigerants ≥ 1,500 GWP prohibited in new systems containing 20-50 lbs.
- Stationary Air Conditioning Measures in 2021
  - Refrigerants ≥ 750 GWP prohibited new systems containing ≥ 2 lbs.
- Sales Restrictions on Refrigerants
  - 2020 – No production, imports, sales, distribution or entry into commerce of refrigerants with a GWP ≥ 2,500.
  - 2024 – No production, imports, sales, distribution or entry into commerce of refrigerants with a GWP ≥ 1,500.
- **Visit CARB's website for official information**
  - **https://ww2.arb.ca.gov/hfc-reduction-measures-rulemaking**

Regulatory Impact in the Decision Making Process

- EPA's Final Rule, July 20, 2015 and September 26, 2016
- Changed listing status of certain hydrofluorocarbons (HFCs)
- Understanding the need to move away from high GWP refrigerants and future proof our business

	Final Rule: July 20, 2015								Final Rule: September 26, 2016			
Phase-out refrigerant	Super-market *(New**)*	Super-market *(Retrofit***)*	Remote condensing unit *(New)*	Remote condensing unit *(Retrofit***)*	Stand-Alone				Refrigerated food processing and dispensing equipment *(New)*	Cold storage warehouses *(New)*	Ice machines *(New)*	Very low-temp refrigeration *(New)*
					MT < 2,200 BTU/hr. and not contain flooded evap. *(New)*	MT ≥ 2,200 BTU/hr. with or without flooded evap. *(New)*	LT *(New)*	LT and MT *(Retrofit***)*				
R-404A/507A	Jan. 1, 2017	July 20, 2016	Jan. 1, 2018	July 20, 2016	Jan. 1, 2019	Jan. 1, 2020	Jan. 1, 2020	July 20, 2016	Jan. 1, 2021	^Jan. 1, 2023	OK	OK
R-410A	OK	-	OK	-	Jan. 1, 2019	Jan. 1, 2020	Jan. 1, 2020	-	Jan. 1, 2021	^Jan. 1, 2023	OK	OK
R-407A/C/F	OK	OK	OK	OK	Jan. 1, 2019	Jan. 1, 2020	Jan. 1, 2020	OK	^Jan. 1, 2021	R-407C/F OK R-407A: ^Jan. 1, 2023	OK	R-407C only
HFC-134a	OK	OK	OK	OK	Jan. 1, 2019	Jan. 1, 2020	OK	OK	OK	OK	OK	-
Likely alternatives (Emerson perspective)												
R-448A/449A	OK	OK	OK	OK	Neither SNAP-approved, nor banned	Neither SNAP-approved, nor banned	OK	OK for LT only	-	-	OK	-
R-450A/513A	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	-
R-290	-	-	-	-	OK	OK	OK	-	-	-	OK	OK
R-744	OK	-	OK	-	OK	OK	OK	-	OK	OK	-	OK
R-717	OK (in primary loop of secondary system)	-	OK (in primary loop of secondary system)	-	OK (in primary loop of secondary system)	OK (in primary loop of secondary system)	OK (in primary loop of secondary system)	OK (in primary loop of secondary system)	OK (in primary loop of secondary system)	OK	OK	-

** Includes ice machines connected to a supermarket rack refrigeration system.
*** EPA uses term "retrofit" to indicate the use of a refrigerant in an appliance that was designed for and originally operated using a different refrigerant. Term does not apply to upgrades to existing equipment where the refrigerant is not changed.

Natural Refrigerants and CO_2

Benefits of CO_2

- 1 – GWP
- 0 – ODP (ozone depletion potential)
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) classified A1 refrigerant
- Non-toxic and non-flammable
- Avoids future refrigerant retrofits
- No charge restriction

Environmental Impact			
Refrigerant		**ODP**	**GWP**
CO_2	R-744	0.00	1
Hydrochlorofluorocarbon (HCFC)	R-22	0.05	1,810
HFC	R-404A	0.00	3,922
HFC	R-407A	0.00	2,107
Hydrofluoro olefin (HFO)	R-448A	0.00	1,273
HFO	R-449A	0.00	1,397
Ammonia	R-717	0.00	0

Natural Refrigerants and CO_2

- Availability of a compact CO_2 booster system design for a small format to help standardize selection and support a lower first cost
- Compact, small format CO_2 booster systems can be used as a centralized refrigeration system for small format stores or as a distributed system for larger format stores

Drivers to Develop

- Indoor package (with or w/o enclosure) and remote air-cooled condenser or adiabatic condenser
- Outdoor package with field-installed condenser
- Outdoor package w/integral air-cooled condenser – future evolution
- Compact package to keep costs at a minimum
- Platform development

Criteria	Traditional	New
Dimension	138”x34”x87”	133”x39”x72”
Weight	5,000 lbs.	4,000 lbs.

Understanding Challenges & Benefits with CO_2 Booster Systems

CHALLENGES

Increased Capital Cost

CO_2 systems do currently cost more

- Driving systems cost reduction to a closer parity with HFC direct expansion (DX) systems
- Cases require electronic expansion valves (EEVs) and case controllers

Availability of Refrigeration Contractors

- The CO_2 Booster systems are similar to traditional DX systems, but require some additional training for installation, start-up and maintenance
- Training available with growing numbers of contractors

Impact on Energy Performance

With the low critical point of CO_2 versus traditional HFC systems, ambient conditions impact the performance of the systems. Adiabatic condensers and parallel compression are recommended in warmer climates.

Understanding Challenges & Benefits with CO_2 Booster Systems

Tangible Benefits

Things We Can Calculate

- Savings on start-up refrigerant charge
- Savings on refrigeration installation
- Savings on electrical installation
- Savings on case performance with EEV's
- Savings on energy

Intangible Benefits

Things We Know, but are Hard to Calculate

- Future cost avoidance of HFC retrofits
- Relief from leak and recordkeeping requirements
- Savings preventative maintenance program w/ lower cost refrigerant
- Better quality product w/ better case controls
- Impact on social responsibility

Understanding TCO and ROI with CO_2 Booster Systems

Impact of an ROI on understanding installed cost vs. equipment's first cost

- Reduced refrigerant cost (reduced charge and cost/lbs.)
- Refrigeration Installation (smaller pipe sizing)
- Electrical Installation (single point electrical with case controllers)

Impact of annual savings and refrigerant management on TCO

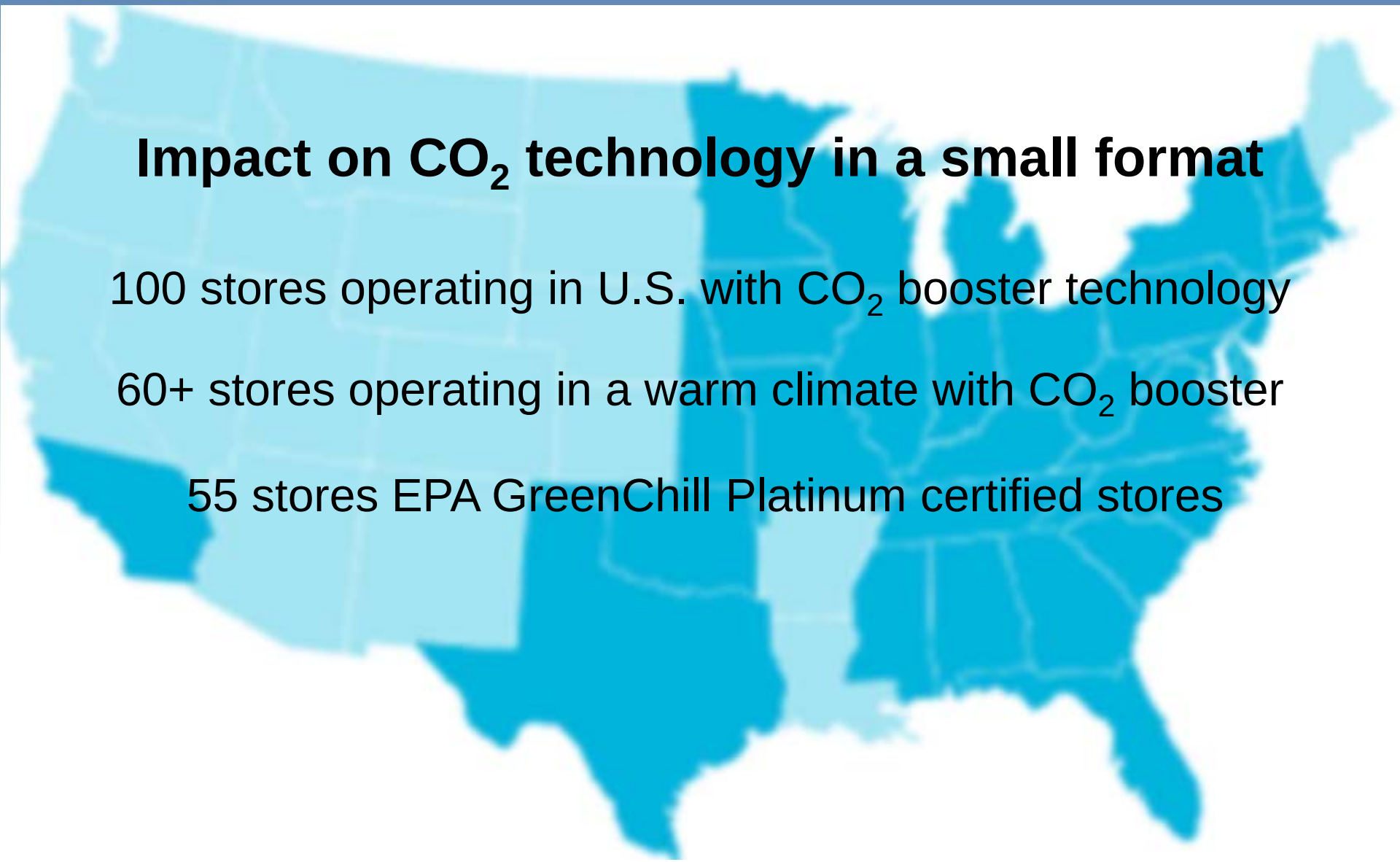
- Annual saving for refrigerant management with lower cost CO_2
- No future refrigerant retro-fit cost
- Improved technology in warmer climates for energy efficiency
- Support from local utilizes with incentives

Understanding TCO and ROI with CO_2 Booster Systems

ROI Summary	Base Design	Optional CO_2 Booster	Difference
Refrigeration Systems	$	$	$
Refrigerated Cases	$	$	$
Estimated Capital Cost	$	$	$
Estimated Start-up Refrigerant Cost	$	$	$
Refrigerant ($/lb.)	$	$	$
Estimated Charge (lbs.)	$	$	$
Estimated Refrigeration	$	$	$
Estimated Electrical	$	$	$
Estimated Installation Cost	$	$	$
Estimated Annual Refrigerant (%)	$	$	$
Estimated Annual Usage (kWh)			
Estimated Annual Operating Cost ($)	$	$	$
Estimated Annual Totals	$	$	$
Utility Incentives			$
Equipment Installed Cost (Equipment & Installation)			$
Balance	$	$	$
Annual Maintenance and Operating Cost Savings			$
ROI in Years			

Baseline system designs and ROI formats are different and can impact the comparison of the system and location used

Growth of CO_2 in Small Format



Impact on CO_2 technology in a small format

100 stores operating in U.S. with CO_2 booster technology

60+ stores operating in a warm climate with CO_2 booster

55 stores EPA GreenChill Platinum certified stores

Impact of Natural Refrigerants on the Environment

- Estimated environmental impact of operating small format stores
- Equivalencies for: 100 stores, 200 lb. charge, 15% leak rate, over 10 years
- 52,475 tons (104,950,000 lbs.) CO_2/ 10 years/ 100 stores

Equivalent Impact	
Cars driven for 1 year	8,711
Gallons of gas	5,403,876
Train cars of coal	252
Tons of recycled waste	16,372
Average household energy use	4,303
Tree growth for 10 years	1,220,569

Contacts and Additional Information

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Upcoming Webinars	
Date	**Topic**
February 13	Tips for Servicing Carbon Dioxide-based Refrigeration Systems
March 6	Experience working with the North American Sustainable Refrigeration Council
April 10	Small, Independent Grocers Participating in GreenChill

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