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DeCO$_2$ded:

Understanding ROI on CO$_2$ Refrigeration Systems

Here's the question many grocers ask when they're considering retrofitting or replacing commercial refrigeration systems: How much will it cost to switch from a traditional hydrofluorocarbon-based system to 100% CO$_2$? But the answer — an immediate dollars-and-cents calculation — is neither sufficient nor strategic. A better question: What's the return on an investment in a 100% CO$_2$ system?

That question prompts a cost/benefit analysis that looks at initial expenditures. But it also delves into the costs that come next — on everything from electricity to regulatory compliance. ROI captures tangible benefits and considers intangible ones, too. Only by analyzing the full return on investment for a CO$_2$ system can grocers really see whether the alternative refrigerant system can save them time and money — and help future-proof their business.

Determining ROI on a CO$_2$ system requires considering the costs of several variables:

- Refrigerant
- Energy
- Equipment
- System installation
- System maintenance and performance
- Regulation

This paper will consider each of those variables, offering real-world ROI calculations on CO$_2$ systems currently operating in three U.S. supermarkets.

Key facts about CO$_2$ refrigeration systems

- Natural and inexpensive refrigerant
- Sustainable, with low global warming potential compared to HFCs
- Requires less refrigerant charge than traditional HFC systems
- Significantly smaller copper piping system than HFC systems
- Energy efficient in most climates and quiet

Determining ROI on CO_2

Refrigerant costs

Some ROI calculations on CO_2 are complex, but that's not true for refrigerants. From Day One, a supermarket that switches to a 100% CO_2 system will save money on refrigerant charge. Here's the math. Say a store needs a start-up charge of 2,000 pounds of refrigerant. HFC-based refrigerant (for example, HFC R404A) will cost $6 per pound. But CO_2 refrigerant comes in at just $1 per pound. So, CO_2 saves $10,000.

Tallying the Return on a CO_2 Booster System: Refrigerant

In this real-world example, a supermarket saw immediate benefits from installing a CO2 booster system with a low-temperature refrigeration load of 200 MBTUH and a medium-temperature load of 650 MBTUH.

ROI Summary	MT HFC DX LT HFC DX	Advansor CO_2 Booster	Difference	
Initial refrigerant cost	$10,500	$3,600	$(6,900)	-65.7%
Annual Refrigerant cost	$2,100	$720	$(1,380)	-65.7%

CO_2 Breakthrough

Sprouts Farmers Market and Hillphoenix Partner on Warm-Climate CO_2 System

A partnership between supermarket chain Sprouts Farmers Market and commercial refrigeration provider Hillphoenix led to an industry breakthrough: the first warm-climate CO_2-based Advansor transcritical booster system.

The hydrofluorocarbon-free refrigeration system, which was installed in a Sprouts store in Georgia in July 2014, overcame a long-standing technological barrier. For years, the retail and refrigeration industries have understood that a CO_2-based system is the cleanest and most environmentally friendly HFC-free option for commercial refrigeration. But they've questioned whether a CO_2-based, air-cooled system could operate efficiently in locations where outdoor ambient temperatures are often above 80°F.

The CO_2 system at Sprouts' metro Atlanta store showed it is possible and put sustainable alternative refrigeration within reach for stores in almost any market.

"Central to Sprouts' identity is a genuine commitment to responsible retailing," said Ted Frumkin, senior vice president of business development for Sprouts. "This innovative partnership with Hillphoenix helps Sprouts reduce our environmental impact, which we know is important to our customers and our team members."

Energy costs

Energy is a huge expense for supermarkets. A 50,000-square-foot store spends more than $200,000 annually on electricity — and half of that is spent on refrigeration, according to the U.S. Department of Energy.

In most cases, CO_2 can be more efficient than traditional commercial refrigeration systems. This is especially true in cooler climates. Supermarkets can save from 5% to 18% on energy bills, depending on their location and source of power.

Equipment costs

The specialized valves, steel piping, compressors and electronic controls used in a CO_2 booster system drive up the cost of equipment, compared to a traditional HFC system. But the cost of CO_2 equipment is following the same pricing pattern as any new technology — from manufacturing equipment to smartphones. Innovative technology is generally more expensive than what's already on the market, yet it also offers new functionality and greater benefits. And the technology gets less expensive as more businesses or consumers adopt it.

Roughly 3,000 transcritical CO_2 refrigeration systems now operate in stores across the globe. Sales are growing as grocers look for ways to increase sustainability and get ahead of coming regulatory changes. Research from market development firm Shecco indicates the use of CO_2 for food retail in Europe has more than doubled since 2011. European sales of Hillphoenix's Advansor CO_2 system have increased 500% since 2009.

Tallying the Return on a CO_2 Booster System: Equipment

The initial price tag for CO_2 refrigeration system equipment is higher than for a traditional system, but CO_2 offers a greater return on investment over time.

ROI Summary	MT HFC DX LT HFC DX	Advansor CO_2 Booster	Difference	
Equipment costs	$870,600	$1,015,235	$144,635	16.6%

Installation costs

Electrical installation generally costs less with CO_2 than with traditional HFC. For example, in CO_2 systems, each case and walk-in uses a case controller, and all of the internal wiring — for lights, anti-sweats, fans, defrosters and sensors — is factory-wired to operate from the controller. So, a single-

point electrical connection is all that's needed. A grocer can eliminate the cost of additional wiring and control boxes from the project's design and installation budget.

Refrigeration installation costs are consistently lower with CO_2. The CO_2 design requires smaller copper pipe sizes, which lowers material costs. And the smaller line sizes in a CO_2 system are easier to install, which lowers labor costs. Overall, grocers can expect savings of 12% to 18% on CO_2 installation, based on projects tracked by Hillphoenix, which has helped supermarkets install more than 50 CO_2 systems in North America since 2012.

Tallying the Return on a CO_2 Booster System: Installation

With CO_2, electrical and refrigeration installations costs are generally lower — driving overall savings.

ROI Summary	MT HFC DX LT HFC DX	Advansor CO_2 Booster	Difference	
Refrigeration install cost	$300,988	$246,000	$(54,988)	-18.3%
Electrical install cost	$126,700	$101,450	$(25,250)	-19.9%

Maintenance and performance-related costs

The case controllers and electronic expansion valves in a CO_2 system control case temperature and superheat automatically. That provides optimal evaporator performance and energy use at all times, and it eliminates the need to do routine maintenance adjustments.

CO_2 case controllers regulate temperature better than traditional systems, improving the shelf life of foods stocked in refrigerated cases. That gives grocers more time to make sales and reduces product shrinkage.

Regulatory costs

Equipment for a 100% CO2, HFC-free commercial refrigeration system has a higher upfront price tag than a traditional HFC system. But CO_2 offers grocers an opportunity to future-proof a significant portion of their capex; save time and headaches going forward; and gain peace of mind. A 100% CO_2 system eliminates the need for refrigerant retrofits and the burden of complying with current and future regulations related to HFCs.

With 100% CO_2 refrigeration systems, stores operate more sustainably — and grocers can add that fact to their list of corporate social responsibility wins.

Adding it Up: A Closer Look at ROI on CO_2

A cost/benefit analysis of CO_2 commercial refrigeration systems currently operating in three U.S. supermarkets shows a positive return on investment across different project sizes. ROI can vary from immediate, upfront savings to a break-even point that occurs 10 years after installation. Note that these charts do not reflect intangible benefits, such as future cost avoidance and reduced regulatory paperwork.

Example A: Based on a low-temperature refrigeration load of 330 MBTUH and a medium-temperature load of 1050 MBTUH

ROI Summary	MT Glycol LT HFC DX	Advansor CO_2 Booster	Difference	
Equipment Costs	**$1,125,353**	**$1,246,939**	**$121,586**	**10.8%**
Initial refrigerant cost	$31,724	$1,980	$(29,744)	-93.8%
Refrigeration install cost	$557,375	$414,933	$(142,442)	-25.6%
Electrical install cost	$75,030	$98,850	$23,820	31.7%
Installation Costs	**$664,129**	**$515,763**	**$(148,366)**	**-22.3%**
Annual refrigerant cost	$4,160	$396	$(3,764)	-90.5%
Annual operating cost	$121,447	$108,622	$(12,825)	-10.6%
Annual Totals	**$125,607**	**$109,018**	**$(16,589)**	**-13.2%**

Equipment Cost Difference	**$121,586**
Installation Cost Savings	**$(148,366)**
Balance	**$(26,780)**
Annual Maintenance & Operating Cost Savings	**$(16,589)**
ROI in Years	**Savings starts at Install**

Example B: Based on a low-temperature refrigeration load of 250 MBTUH and a medium-temperature load of 750 MBTUH

ROI Summary	MT HFC DX LT HFC DX	Advansor CO_2 Booster	Difference	
Equipment Costs	**$826,570**	**$1,024,630**	**$198,060**	**24.0%**
Initial refrigerant cost	$20,800	$2,250	$(18,550)	-89.2%
Refrigeration install cost	$398,486	$298,000	$(100,486)	-25.2%
Electrical install cost	$277,388	$248,000	$(29,388)	-10.6%
Installation Costs	**$696,674**	**$548,250**	**$(148,424)**	**-21.3%**
Annual refrigerant cost	$3,188	$275	$(2,913)	-91.4%
Annual operating cost	$110,332	$93,477	$(16,855)	-15.3%
Annual Totals	**$113,520**	**$93,752**	**$(19,768)**	**-17.4%**

Equipment Cost Difference	**$198,060**
Installation Cost Savings	**$(148,424)**
Balance	**$49,636**
Annual Maintenance & Operating Cost Savings	**$(19,768)**
ROI in Years	**2.5 years**

Example C: Based on a low-temperature refrigeration load of 200 MBTUH and a medium-temperature load of 650 MBTUH

ROI Summary	MT HFC DX LT HFC DX	Advansor CO_2 Booster	Difference	
Equipment Costs	**$870,600**	**$1,015,235**	**$144,635**	**16.6%**
Initial refrigerant cost	$10,500	$3,600	$(6,900)	-65.7%
Refrigeration install cost	$300,988	$246,000	$(54,988)	-18.3%
Electrical install cost	$126,700	$101,450	$(25,250)	-19.9%
Installation Costs	**$438,188**	**$351,050**	**$(87,138)**	**-19.9%**
Annual refrigerant cost	$2,100	$720	$(1,380)	-65.7%
Annual operating cost	$122,459	$113,500	$(8,959)	-7.3%
Annual Totals	**$124,559**	**$114,220**	**$(10,339)**	**-8.3%**

Equipment Cost Difference	**$144,635**
Installation Cost Savings	**$(87,138)**
Balance	**$57,497**
Annual Maintenance & Operating Cost Savings	**$(10,339)**
ROI in Years	**5.6 years**

Conclusion

A grocer who's considering retrofitting or replacing commercial refrigeration systems will gain a truer view of the costs and benefits of different systems by considering more than just initial price. Comparing the short- and long-term return on investment of traditional HFC systems vs. CO_2 systems offers a more thorough analysis. Determining ROI on commercial refrigeration systems requires considering variables such as the cost of refrigerant, energy, equipment, installation, maintenance and regulation. Understanding ROI allows a grocer to make strategic, forward-thinking decisions that not only meet today's challenges, but also help future-proof the business.

About Hillphoenix

Hillphoenix Inc., a Dover Company, is based in Conyers, Georgia. The company designs and manufactures commercial refrigerated display cases and specialty products, refrigeration systems, integrated power distribution systems and walk-in coolers and freezers. Visit www.hillphoenix.com or call 800-283-1109 for more information.