



**System Type: Transcritical CO<sub>2</sub>**  
**Refrigerant: R-744**  
**GWP: 1**

BP Marks & Spencer St. Ives, United Kingdom	<i>Charge Size</i>	165-lb R-744
	<i>Store Size</i>	Small format (<3,000 sq ft) convenience store
	<i>System Capacity</i>	MT = 170,600 BTU/hr LT = 68,200 BTU/hr
	<i>System Location</i>	External unit an an integrated gas cooler. Compact footprint (13 x 3 ft)
	<i>ASHRAE CLimate Zone</i>	4
	<i>Average Electricity Cost</i>	\$0.14/kWh
	<i>Baseline for Comparison?</i>	Yes. HFC DX system in nearby store with same square footage.
	<i>Key Characteristics</i>	Fully integrated transcritical CO <sub>2</sub> system, with a second temperature band specifically for air-conditioning. Heat recovery supplies all building heat demand. The system was designed as a low noise solution (30dB(A) @ 32 ft) due to the surrounding residential property.

### SYSTEM BASICS

Requirement was for a fully integrated refrigeration system that would provide all refrigeration capacity and a second temperature band for air-conditioning, in addition to meeting all building heat demand through heat recovery. The design was presented and approved in late 2013, with the installation complete and running by July 2014.

The dual temperature CO<sub>2</sub> transcritical (TC) rack was completed with a purpose-built

Programmable Logic Controller (PLC) and plate heat exchanger/ 3-way valve arrangement for heat recovery. Pressure Relief Valve (PRV) set points are 1,160 psi liquid and 870 psi suction, which ensures that the charge is not lost in the event of a power failure. The PLC user-interface allows for remote access to the unit via a phone/ tablet app.

The remote cases for this installation were typical BP cases adapted for the higher operating and standstill pressures of TC CO<sub>2</sub>.

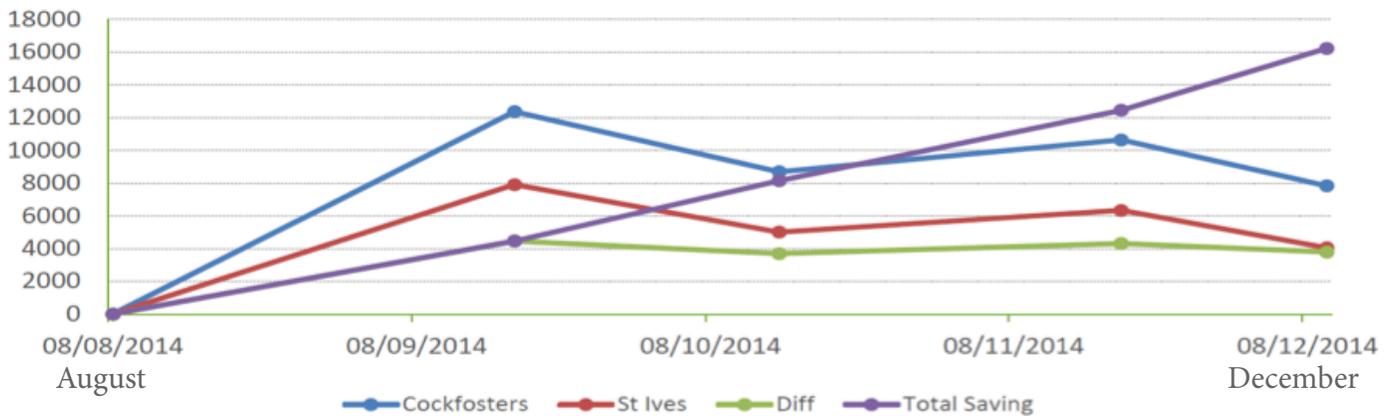
## QUANTIFYING & COMPARING ENERGY USE

For comparison, energy data was collected over the same period at the BP store in Cockfosters, UK with the exact same store footprint. Cockfosters is just outside of London, and experiences similar seasonal temperatures as St. Ives.

The following graph shows electricity usage in the St. Ives TC store as compared to the HFC store in Cockfosters. Sub-metered data were collected on a monthly basis from September 2014 through December 2014 showing the energy use for refrigeration and AC, respectively. After four months of data, total energy savings from the TC installation were 41% as compared to the HFC system in Cockfosters. As shown in the chart, a majority of the energy savings is due to heat recovery and reuse in the HVAC system; however the TC refrigeration system was 12% more efficient than the HFC system.

**What BP Says:**  
 "On the back of this successful pilot project further stores were trialed, and going into 2016 this integrated TC solution has now become the standard engineering solution for BP Marks & Spencer Simply Food franchises moving forward."

Combined Refrig & HVAC kWh



System Item	Energy Savings (kWh)	Energy Savings (%)
Combined Refrigeration & HVAC	16,221	<b>41.07%</b>
Refrigeration Plant Only	2,981	12.15%
HVAC Equipment Only	13,330	84.88%



The North American Sustainable Refrigeration Council is a 501(c)(3) nonprofit dedicated to advancing natural refrigerants and creating a more sustainable future for retail food refrigeration.

Learn more at <http://nasrc.org>