



Variable Refrigerant Flow (VRF)

Innovative Technology Can Cut Small-format Retailer's HVAC Energy Cost by 45%

Convenience stores (C-stores) and small-format retailers have been making significant strides in energy efficiency and sustainability with a focus on reducing their operating costs via energy efficiency initiatives, adopting sustainable store designs, and LEED® certification for new store constructions. While many C-Stores and small-format retailers have installed energy efficient LED lighting for outside canopies and refrigerated cases and made improvements to the refrigeration systems – multiplex systems and waste heat recovery, HVAC has been one area that has not received a lot of attention. It does not have to be that way!

[Fig 1. Applied Commercial AC in 2011(\$M)]

Region	Total Market Size	VRF (%)
Global	20,755	4,898 (23.6%)
China	3,275	2,185 (66.7%)
India	594	224 (37.7%)
Eastern EU	376	156 (41.5%)
EU	3,299	1,163 (35.5%)
Other Asia	1,632	412 (25.2%)
MEA	1,954	291 (14.9%)
South Central America	1,270	187 (14.7%)
North America	8,355	280 (3.4%)

Variable Refrigerant Flow (VRF) HVAC systems enable you to reduce your HVAC energy costs by over 45% which would qualify some retail stores for up to 6 LEED® points, and reduce annual maintenance expenses as well. VRF technology has been widely adopted in Europe, China, India, and rest of Asia with greater than 25% applied air conditioning market share. The mature network of engineers, architects and installers that are more familiar with cheaper roof top units, have been slower to adopt VRF in the US [Fig 1].



What is VRF (Variable Refrigerant Flow)?

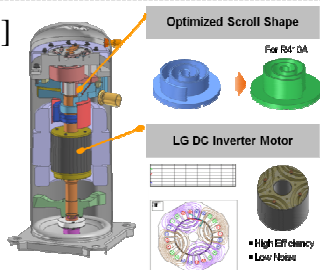
VRF is an air conditioning system comprised of refrigerant pipes connected to a single outdoor unit and multiple indoor units that offers outstanding energy savings, zone control, and simple and easy installation[Fig 2]. A VRF based system eliminates needs for ductwork as the refrigerant is passed through copper pipes from the outdoor unit and cooling or heating takes place in the indoor evaporator units in the individual room or zone. This key feature results in a modular system and flexible design options based on the store building requirements. The modular design allows for reduced construction time and labor costs, and also allows for independent cooling and heating control according to each zone's needs. All Multi-V indoor units contain an electronic expansion valve (EEV) that adjusts the flow of refrigerant based on setpoint and room temperature.

[Fig 2]



Most outdoor units are comprised of dual compressors – one constant speed and other DC inverter variable speed compressor that offers superior load matching and prevents constant cycling and large temperature swings [Fig 3]. Tight temperature control ensures maximum comfort, efficient operation, and superior dehumidification. Indoor units are available in a wide range of styles - ceiling mount, cassettes, wall mounted, ducted units to fit your interior designs. In addition, the indoor units like the 1-way, 2-way, and 4-way cassettes offer easy installation and maintenance options like drop-down grill covers to change out the filters [Fig 4].

[Fig 3]



[Fig 4]



VRF systems do not need to frequently replace condenser fan motors and belts, reducing lifecycle maintenance costs. This also reduces noise emissions with outdoor units operating as low as 58dB(A) and indoor units as low as 23dB(A). Finally, VRF systems provide the user with central monitoring application to enable control over the entire system from a single location or via the web.

LG Electronics has recently launched the Multi-V III, the newest and most advanced VRF technology in the US market and is actively working to increase its adoption within retail space

An internal LG energy study demonstrates 45%-65% savings in annual HVAC energy costs for a LG Multi-V III design over comparable roof top packaged units

LG's portfolio of energy efficient VRF technology and LED retrofit lamps and fixtures can help you achieve your energy and sustainability goals



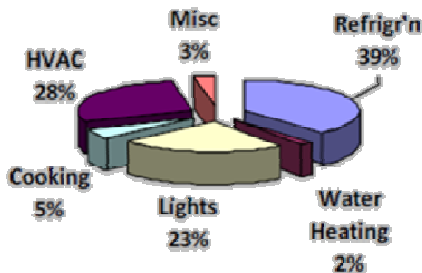
Benefits of VRF



45% Energy Reduction

With the C-Store industry's net margins at 1%, done correctly, energy efficiency is a cost effective way to reduce operating costs and improve margins. Since HVAC and lighting can make up more than 50% of total energy consumption for a typical store [Fig 5], C-Stores should take advantage of every opportunity in choosing more energy efficient solutions. An internal LG energy study demonstrates 45%-65% savings in annual HVAC energy costs for a LG Multi-V III design over comparable roof top packaged unit designs. LG's portfolio of energy efficient VRF Technology Multi-V III HVAC products with LED retrofit lamps and recessed lighting fixtures can help you achieve your energy and sustainability goals.

[Fig 5]



< Source: NACS, SOI report – 2009 >



For More Information

On the energy study and how LG Electronics can help you save energy and reduce costs:

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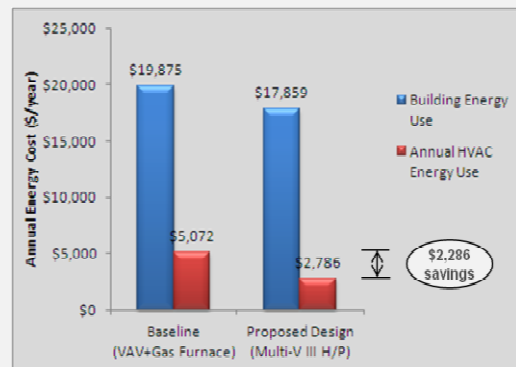
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Additional information on VRF technology and Multi-V products, go to www.lg-vrf.com

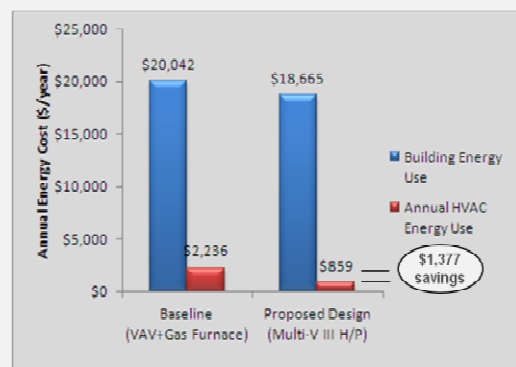


Energy Study

An internal LG energy study demonstrates 45%-65% savings in annual HVAC energy costs for a LG Multi-V III design over comparable roof top packaged unit designs. [Fig 6, 7]. This equates to over \$2,200 in annual energy cost savings for a typical C-Store. The energy study was conducted for a new C-Store (5,870 sq. ft) building that meets the LEED® 2009 requirements per the ASHRAE 90.1-2007 standard in two different locations - Boston and Los Angeles.



[Fig 6. Boston]



[Fig 7. Los Angeles]

In addition, VRF systems eliminate the need for fans to push conditioned air through a ductwork system and create easy accessibility to air filters resulting in reduced maintenance costs. Energy and maintenance costs savings together improve margins and go straight to your bottom line.



Details of the Energy Study

An energy study was conducted for a new C-Store building that meets the LEED® 2009 requirements. The building was modeled in two different locations, Boston and Los Angeles per the ASHRAE 90.1-2007 standard using the simulation tool, eQUEST. Only interior store fluorescent lighting has been considered for the lighting load calculations.

Store Details

Location : Boston, MA & Los Angeles, CA

Size : new one-story 5,870 sq. ft

- Retail area : 3,200 sq. ft
- Other area: 2,670 sq. ft subway service, office area, walk-in cooler areas

Operation hours :

- 24 hrs for the Retail area
- 6am - mid night Quick Serve Restaurant area/office/MPA (Merchandise Process Area)

Equipment Comparison

	Baseline	LG Proposed Design
Cooling	2 - 12 RT RTU VAV System (EER: 11.0)	2 - Multi-V III (EER: 11.80)
Heating	Gas-fired furnace ($\eta=0.8$)	2 - Multi-V III (COP:3.45)
Air Handling Systems	2 - RTU VAV system, 4,800 cfm, 0.6" wg	2 - Multi-V III Heat pump + 6 ceiling concealed ducted (high static) indoor units, 4,800 cfm (1,200 ea) 0.4" wg
Hot Water	Gas fired storage water heater ($\eta=80\%$)	same
Energy Recovery	Interlock with RTU1 and RTU2, wheel type energy recovery ventilators (total $\eta=50\%$, 1,100 cfm)	same

Modeling Parameters

Boston – Building exterior U-factor=0.113, metal roof U-factor=0.065, windows U-factor=0.55 and shading coefficient=0.465. Average Utility rates=\$0.125/kWh, \$1.354/therm

Los Angeles – Building exterior U-factor=0.123, metal roof U-factor=0.048, windows U-factor=0.65 and shading coefficient=0.287. Average Utility rates=\$0.149/kWh, \$1.348/therm

Annual Energy Consumption By End Use

	Baseline Design		Proposed Design Multi-V III	
	Electricity (kWhX000)	Natural Gas (MBTU)	Electricity (kWhX000)	Natural Gas (MBTU)
Area Lights	56.29	0.0	56.29	0.0
Equipment	61.69	0.0	61.69	0.0
Hot Water	0.0	8.7	0.0	8.7
Space Cooling	7.14	0.0	2.77	0.0
Space Heating	5.28	239.1	14.0	0.0
Ventilation Fans	2.31	0.0	1.3	0.0
Total	132.7	247.8	136.1	8.7

<Annual Energy Consumption, Boston>

	Baseline Design		Proposed Design Multi-V III	
	Electricity (kWhX000)	Natural Gas (MBTU)	Electricity (kWhX000)	Natural Gas (MBTU)
Area Lights	56.29	0.0	56.29	0.0
Equipment	61.69	0.0	61.69	0.0
Hot Water	0.0	5.54	0.0	5.54
Space Cooling	12.28	0.0	5.97	0.0
Space Heating	0.79	24.31	1.81	0.0
Ventilation Fans	0.99	0.0	0.38	0.0
Total	132.05	29.85	126.15	5.54

<Annual Energy Consumption, Los Angeles>