



ENERGY EFFICIENCY IN SUPERMARKETS

Secondary Loop Refrigeration Pilot Project In the Repentigny Loblaws

Prepared by:

Georgi Pajani, Daniel Giguère and Sophie Hosatte
CANMET Energy Technology Centre - Varennes
Natural Resources Canada

Provigo Inc., a member of the Loblaws family, has taken the initiative to install innovative technologies at its new Loblaws supermarket in Repentigny. The technologies are designed to reduce energy consumption as well as greenhouse gas emissions while improving product quality and customer comfort. Undertaken in partnership with Natural Resources Canada's CANMET Energy Technology Centre - Varennes (CETC-Varennes), the project enabled the company to create an environmentally friendly supermarket by installing an efficient refrigeration system, integrated with the building's heating, ventilation and air conditioning (HVAC) system. And what makes this a truly special achievement is that the project is the first of its kind in Canada.

A supermarket consumes enormous amounts of energy (over 800 kWh per square metre per year) because, although it is heated, ventilated and air conditioned like any other building, it also has a refrigeration system that keeps food cool or frozen—and that accounts for about half of the building's total energy consumption. The refrigeration systems of most supermarkets use large quantities of synthetic refrigerant (roughly 1,000 to 2,000 kg of HCFC or HFC per store), which circulate under pressure, from the mechanical room to the refrigerated display cases, through kilometres of jointed piping that is the source of significant leakage, estimated at 10 to 30% a year. Although, since the Montreal Protocol, these refrigerants are now harmless to the ozone layer, they are nevertheless powerful greenhouse gases (GHGs), that are 1,500 to 3,000 times more damaging relative to an equivalent mass of CO₂.

The refrigeration system in a supermarket is generally designed as an isolated process intended to produce cold. While most of the heat extracted from refrigerated display cases is released into the environment, the quantity involved is much greater than the energy needs of the store and could easily meet its heating and hot-water requirements, even on the coldest winter days. Another operational feature of the refrigeration system is that it releases its heat at temperatures above 30°C, a level adapted to the climate in the southern U.S., but not designed to take advantage of the Canadian climate.

CETC-Varennes and Provigo/Loblaws cooperated closely on this demonstration project to implement the following strategies at Repentigny: refrigeration system and synthetic refrigerants confined to the mechanical room; cold distribution via two secondary loops; integration of the refrigeration system with the HVAC system (integrated HVAC-R); and heat recovery via a secondary loop; variable condensation pressure (floating head pressure).

As shown in Figure 1, two secondary fluids—potassium formate for low temperatures (around -25 °C) and propylene glycol for moderate temperatures (around -5°C)—which have no environmental impact, are cooled by the refrigerant through a heat exchanger. They then circulate through pipes from the mechanical room to the refrigerated display cases at near-atmospheric pressure, thus reducing the possibility of leaks. The use of another secondary fluid (ethylene glycol) on the hot side of the refrigeration system, makes it easier to recover the superheat from the compressor as well as the condensation heat to be used to meet the heating

and hot water needs of the building. Finally, the HVAC-R system is managed in such a way as to take advantage of the Canadian climate. This means that the system—specifically the temperature or pressure of condensation—is optimized on the basis of two criteria: heating needs (recovery) and outside temperature, thereby offering another means of improving energy performance.

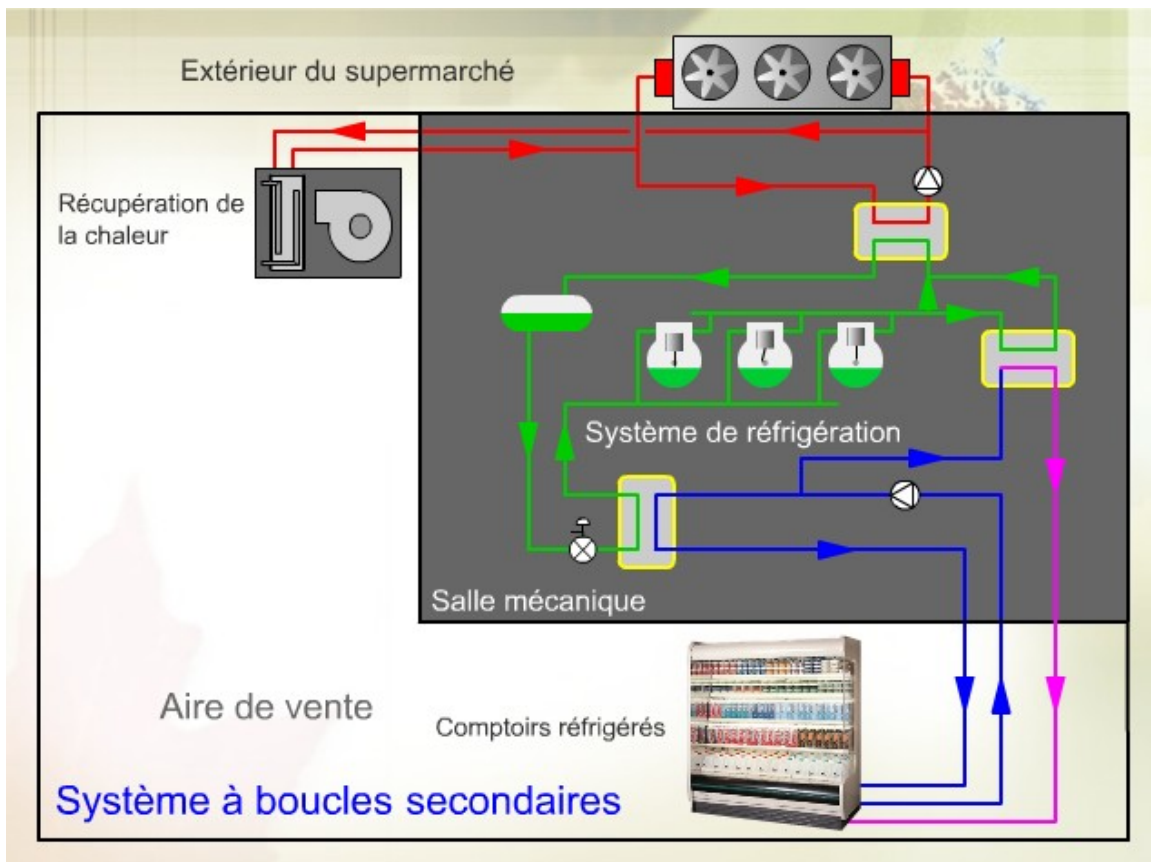


Figure 1 : Système à boucles secondaires

The integrated secondary-loop HVAC-R system (see Figures 2 and 3) makes it possible to reduce the amount of synthetic refrigerant by about 80% relative to quantities used by conventional supermarkets. As shown in Figure 4, the project is expected to reduce energy consumption by 18% and GHGs by about 75% relative to conventional supermarkets of equivalent size. This decrease in GHGs corresponds to emissions from 430 family-size cars travelling 20,000 km a year. The system also has other benefits: ease of operation and maintenance, more stable food temperatures resulting in improved product quality and longer conservation times, and added comfort for store customers.



Figure 2 : Suction by low-temperature compressors



Figure 3 : Secondary fluid pumping system for heat recovery

	Units	Typical Supermarket	Pilot supermarket	Reduction
Energy consumption				
Total	kWh eq./yr	9,450,000	7,750,000	18%
Refrigeration	kWh eq./yr	4,210,000	3,450,000	18%
Heating	kWh eq./yr	1,700,000	205,000	88%
Synthetic refrigerants – Load				
Load	kg	1,500	300	80%
Leaks	kg/yr	250	10	96%
Energy saved	kWh/yr		2,255,000	24% of total consumption 38% of HVAC-R
Reduction in GHG emissions	kg eq. CO ₂ /yr		2,000,000	73%

Figure 4: Projected impacts

The 10,000-square-metre (102,000-square-foot) Loblaws supermarket in Repentigny opened for business on April 28, 2004, and the integrated HVAC-R system has been operating successfully. Using the installed instrumentation, CETC-Varenes will monitor and analyse system performance for one year.

The project is part of the CETC-Varenes Refrigeration Action Program for Buildings (RAPB). The RAPB is funded through the Climate Change Plan for Canada which, in keeping with the government's commitment under the Kyoto Protocol, aims to reduce greenhouse gas emissions in Canada. The goals of the RAPB are to reduce GHG emissions by 1.6 Mt of CO₂ equivalents a year, and energy consumption by 1,700 GWh equivalents a year by 2012, in the supermarkets, ice rinks and curling rinks of Canada. Information activities, skills development and demonstrations, and the development of constructive partnerships will make these goals a reality.



In conclusion, it is interesting to note that the substantial environmental benefits to be achieved through this new approach to designing refrigeration systems requires no specific expenditures, because the energy savings finance the entire investment within a timeframe acceptable to the owner.

Acknowledgements

We wish to thank Loblaws/Provigo for their confidence in this project, as well as all the technical and financial partners: Hill-Phoenix, Hussmann, Keeprite, Consolidated Energy Solutions, MicroThermo, Hydro-Québec, l'Agence de l'efficacité énergétique du Québec, and the Office of Energy Efficiency and the TEAM program (*Technology Early Action Measures*) at Natural Resources Canada.



RAPB