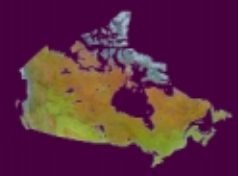


Energy Innovators Initiative

Energy Innovators Case Study

March 2003

ENERGY EFFICIENCY UPGRADES AT CHARLES LEMOYNE HOSPITAL SAVE $360,000 PER YEAR

Pierre-Klébert Charles, P. Eng.
Facilities Operation Manager
Charles LeMoyne Hospital

Introduction

Established in 1966, the Charles LeMoyne Hospital (HCLM) is the affiliated university hospital centre for the Montérégie region. Located near the main airways and highways on Montréal's South Shore, the HCLM provides a broad range of medical services to a population of 400 000 and specialized or highly specialized care to nearly 1.4 million people. With 571 authorized beds, 2270 employees – 281 active, associate and consulting physicians (including 215 specialists) – and an annual budget exceeding $120 million, it is one of the 10 largest hospital centres in Quebec.

Why Introduce an Energy Efficiency Program?

In response to a request by the Canadian Council on Health Services Accreditation (CCHSA) to develop a strategic plan, the HCLM is putting in place a three-year plan directed at its institutional activities. This future-oriented plan defines a structured, ongoing and participatory process and identifies

- actions required;
- an implementation plan;
- time lines; and
- an evaluation of results.

This plan is part of the management approach proposed by the Clair Commission, which focuses on prevention, cure and health services delivery based on continuous improvements in the quality and performance of the institution's services.

The energy efficiency upgrade program is part of the CCHSA's overall management approach and is yielding tangible results. The HCLM's annual energy savings are estimated to be approximately $360,000.

Hospital expansion project

Background

The HCLM's energy efficiency program was launched in the early nineties. A building energy management program and support for such a program fit in perfectly with the hospital's strategic planning approach – especially at a time when the HCLM had to deal with steadily increasing energy costs. A more judicious use of energy is one of the actions proposed

under the HCLM's strategic plan. As part of the plan's objectives and through a number of actions, the hospital wanted to keep its energy consumption levels below 1992–1993 fiscal year levels, notwithstanding a number of upgrades and expansion projects already planned.

Energy Use at the HCLM

The HCLM uses electricity and natural gas as its principal sources of energy. In addition, the facility has provisions for a backup energy source, type 2 fuel oil, to take advantage of an interruptible rate offered by Gaz Métropolitain.

Six services account for most of the hospital's energy use:

- Laundry: hot water and steam for washing, steam for drying, as well as electricity and steam for pressing.
- Food services: mainly electricity for cooking and steam for some food services uses.
- Sterilization unit: mainly steam.
- HVAC systems: gas for heating and electricity for motors, air conditioning and ventilation.
- Lighting: electricity only.
- Hot water: used for hydrotherapy and mainly for domestic purposes. Water is preheated through boiler energy recovery and, if necessary, steam-heated.

HCLM's Energy Efficiency Upgrade Program

In order to assess the results of HCLM's energy program, a reference or baseline year of typical energy consumption was chosen. The HCLM chose the 1992–1993 fiscal year as its baseline for the analysis of its energy efficiency measures. Due to ongoing changes at the hospital, the analysis of raw data will need to be adjusted to take into account modifications made to the facilities over time. In this regard, energy consumption increases due to expansion have not been estimated, but costs have been calculated per square metre (m^2).

An energy efficiency study conducted in the winter of 1992 was the starting point for the HCLM's energy efficiency upgrade program. The study recommended replacing two of the three 550-BHP (boiler horsepower) boilers with two new 600-BHP boilers. This was complemented by adding a direct-contact recuperator to recover the waste heat from boiler exhaust gases and by modernizing the building's automatic control system. Each specific upgrade measure is described in the following.

1. Boiler Replacement

This upgrade was designed to achieve the following benefits:

- More efficient boiler combustion; and
- More efficient use of human resources, i.e., stationary engineers and lower machine maintenance costs.

Additional benefits also occurred as part of the initial boiler replacement, including the following:

- The replacement of old conventional boilers with coil-tube boilers increased energy efficiency by about 5 percent. The enhanced efficiency is primarily due to the nominal increase of the burner efficiency when operating at full load. Moreover, boilers operating at under 50 percent of nominal capacity are seriously affected by poor energy performance. In mid-season, the new burners allow for adjustments to be made within an operating range of 7 to 1 to meet the demand for steam while avoiding any form of cycling.
- Changes to the heating plant have also made it possible to easily control the new equipment. In fact, with this improved system, it is possible to monitor the equipment on a periodic basis instead of continuously. With continuous monitoring, the stationary engineer could not leave the premises for more than one hour for every two-hour period. With periodic monitoring, an operational check of the equipment is required only once every 24 hours. This major shift in monitoring requirements has decreased the HCLM's human resources requirements and enabled current employees to broaden their range of skills and duties through training in related fields (e.g., monitoring, refrigeration, preventive maintenance), and thus the maintenance service costs of contracts with outside firms can be substantially reduced. These changes help generate annual savings of about $130,000.

The boiler replacement has also had a major positive effect on outside air quality because fewer emissions are released into the atmosphere. Furthermore, the HCLM has installed low-nitrous-oxide (NO_x) burners to further enhance the effect on air quality. The use of these burners allows a percentage of the combustion gases to be recovered and returned to the burner, thereby enhancing combustion efficiency, and at the same time reducing NO_x emissions. By combining higher-efficiency burners with a combustion gas recuperator, the hospital reduced its natural gas consumption by more than 515 000 m^3 in 1996–1997, significantly reducing the amount of greenhouse gas emissions and air pollutants being released into the atmosphere.

Table 1. Reduction in Consumption of Natural Gas and its Emissions

	Natural Gas (m^3)	CO_2 (tonne)	NO_x (tonne)	CH_4 (tonne)
1996–1997	514 731	952	3.68	0.44
1997–1998	463 053	856	3.31	0.40
1998–1999	494 174	914	3.53	0.42
1999–2000	407 023	753	2.91	0.35
2000–2001	107 215	198	0.77	0.09
Average	397 239	735	2.84	0.34

By replacing these boilers, emissions of an estimated 952 tonnes of carbon dioxide (CO_2), 3.68 tonnes of NO_x and 0.44 tonne of methane (CH_4) emissions were avoided in 1996–1997 (see Table 1).

2. Installation of a Direct-Contact Recuperator

A direct-contact recuperator is used to recover latent, sensible energy from combustion gases in boilers, increasing their energy efficiency to nearly 100 percent by lowering the temperature of hot gases from 200°C to 21°C. This is done by atomizing cold water (10°C) inside a cylinder with a hot-air transfer medium. The atomized water then comes in direct contact with the hot exhaust gases. The energy from the gases is transferred to the water, which can be preheated to a temperature as high as 60°C. The use and efficiency of a direct-contact recuperator is contingent on sufficiently high demand for hot water and a sufficiently low water temperature. The hot water requirements of a laundry generate an equivalent demand for cold water from the municipality. To ensure that the recuperator performs efficiently, the cold water intake can be adjusted to fluctuations in water temperature. At the HCLM, the demand for clean water used in the laundry room and for a backup water supply for the boilers and for domestic hot water was high enough to warrant installing a direct-contact recuperator.

Direct-contact recuperator

A recuperator increases the nominal efficiency of steam boilers by over 20 percent. Although new, the steam boilers' maximum efficiency is 80 percent. Under optimal operating conditions, the installation of a recuperator can increase a hospital's steam boiler's combustion efficiency to almost 100 percent and will reduce natural gas consumption by more than 15 percent.

3. Computerized Control System

Energy savings generated through a centralized control system are directly related to its ability to control the fresh-air intake. The system must be able to adjust the intake based on the amount of pollutants in the air, the ambient and outside temperatures, and CO_2 concentrations. The HCLM's computerized electromagnetic-relay multiplexing control system was installed in the sixties. The system required major upgrades to accommodate various expansion projects at the hospital. Since the system's energy management potential was inadequately developed in terms of the actual ventilation requirements, it was decided to replace the system.

By optimizing the stop-start and adjustment sequences to control the fresh-air intake, it was possible to reduce natural gas consumption by 5 percent and electricity consumption by approximately 3 percent. In addition, the ability to limit ventilation use also has a direct impact on the motors' useful life.

For all new expansion projects, variable frequency drives have also been installed to control motor speed.

Variable frequency drive

Power factor correctors

4. Improvements in Electric Motor Efficiency

Electric motors account for 11 percent of the HCLM's overall annual energy consumption and more than 34 percent of electricity consumption. The energy bill to run the electric motors for the baseline year exceeded $210,000. Therefore, replacing old motors with high-efficiency ones was a key step in carrying out the HCLM's energy efficiency upgrade program. With the help of a Hydro-Québec financial assistance program for the installation of high-efficiency electric motors, the HCLM replaced 20 percent of its electric motors. This enabled the hospital to increase the electrical power of its motors by 25 percent, with an associated increase in motor efficiency of 5 percent on average. To link the motors up with the variable frequency drives described above, conventional motors were replaced with high-performance motors for certain variable-speed systems.

5. Efficient Lighting

Because exit signs are continuously lit, their cumulative energy consumption is considerable. At the HCLM, all 30-watt exit signs were replaced with signs lit by 2.5-watt light-emitting diode (LED) lamps, resulting in a 91.7 percent drop in energy required for the exit signs. Since there are more than 250 exit signs in the institution, this simple measure has generated ongoing savings of 60 000 kWh per year, or 0.5 percent of HCLM's total electricity consumption.

Similarly, low-efficiency incandescent and fluorescent lights were replaced with more efficient ones, generating significant savings. Accordingly, a gradual replacement program for the lighting systems was introduced. So far, over 35 percent of the systems have been replaced.

The lighting system upgrades have generated an additional electricity savings of more than 0.5 percent on the total electricity consumption. These changes have extended the useful life of the equipment and, at the same time, they have reduced human resource requirements and enabled the HCLM to give other duties to workers assigned to light-bulb replacement.

6. Awareness Initiatives

Staff awareness is advocated by Natural Resources Canada's Office of Energy Efficiency (OEE) and other agencies that have an energy efficiency mandate as another way of achieving energy savings. Improving energy efficiency reduces greenhouse gas emissions that contribute to climate change. A member of the OEE's Energy Innovators Initiative since February 2002, the HCLM joined the program to gain access to its services, incentives and energy efficiency information. An awareness program, developed by the HCLM for employees as well as building occupants, incorporates activities not only directed at HCLM staff but also the hospital's occupants. To take advantage of this low-cost method of achieving savings, an in-house energy management committee was created. By allowing employees and occupants to exercise some control over energy use and making them aware of energy efficiency objectives, it is possible to motivate them to contribute to real, measurable results. Although difficult to quantify the impact of awareness activities, it is estimated that employee awareness can help reduce the energy bill by approximately 2 percent.

7. Energy Maintenance Program

A bank of condensers was installed to help the hospital optimize its power factor. Condensers will allow the more efficient use of energy and thereby minimize penalties from power suppliers. Monthly equipment monitoring and maintenance provide for optimal utilization of the power factor.

The HCLM's steam-generating equipment was inefficient, accounting for nearly 25 percent of natural gas use before the implementation of the energy savings program. As such, it was the first system to be upgraded. To ensure that corrective measures would be implemented on an ongoing basis and to maintain its facilities in working

condition, the HCLM launched a preventive maintenance and performance monitoring program.

Similarly, combustion air intake was modified to increase the burners' combustion efficiency. The combustion air supply comes from hot air accumulating in the steam plant ceiling. With the building management system in place, the HCLM can benefit from energy-related savings, both in terms of electric motor use and fresh-air heating. The use of a temperature probe and a CO_2 detector can also optimize the fresh-air intake system and ventilator operation.

Energy losses caused by a defective steam trap can amount to thousands of dollars annually. A strict steam trap maintenance program has been implemented under which all defective traps in the steam distribution system are to be systematically replaced every year.

8. Energy Rates Optimization

Electricity: To take advantage of Hydro-Québec's best possible rates, the hospital developed a monthly monitoring program. Since pricing regulations allow customers to change the contracted load over time, the load demand has been periodically adjusted according to monitoring results. This measure not only allows the HCLM to take advantage of the rate structure offered by Hydro-Québec, it is also useful in highlighting the load demand impact and thus encourages the hospital to look for ways to optimize its energy demand. To facilitate this endeavour, an electronic counter has been installed to give instantaneous readings of load demand and provide for a more effective operational management of air-conditioning equipment.

Natural gas: With the interruptible service contract option offered by Gaz Métropolitain, the HCLM's gas bill can be reduced by 20 percent annually. However, in order to benefit from this option, the institution must be able to obtain a supply from a replacement fuel source. Since the burners in the new boilers work with natural gas and type 2 fuel oil, additional tanks were installed to store the replacement fuel.

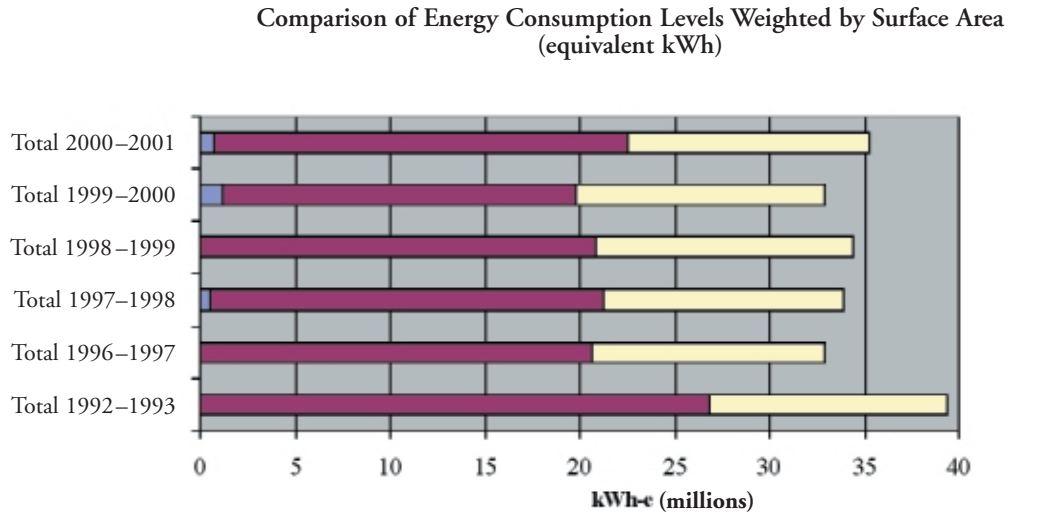
Results

Although easier to quantify energy savings for a single, specific measure, since the HCLM's energy efficiency program was implemented gradually over time, an analysis of the results includes the impact of all measures on overall energy consumption. It is important to note that the sequence in which upgrades were made will also affect the results.

Program results take into account all the measures, changes in energy costs over time, changes to the size of the building – from 43 124 m^2 in 1992 to 47 748 m^2 in 1999 to 50 407 m^2 in 2000 – as well as the increased number of services provided.

High-efficiency burner

Figure 1. Energy Impact



	Total 1992–1993	Total 1996–1997	Total 1997–1998	Total 1998–1999	Total 1999–2000	Total 2000–2001
Electricity	12 556 631	12 314 672	12 581 879	13 539 196	13 107 847	12 657 600
Natural Gas	26 806 283	20 573 071	20 702 402	20 822 009	18 629 146	21 822 459
Type 2 Fuel Oil	0	0	526 072	0	1 129 586	719 960

Energy Impact – Methodology

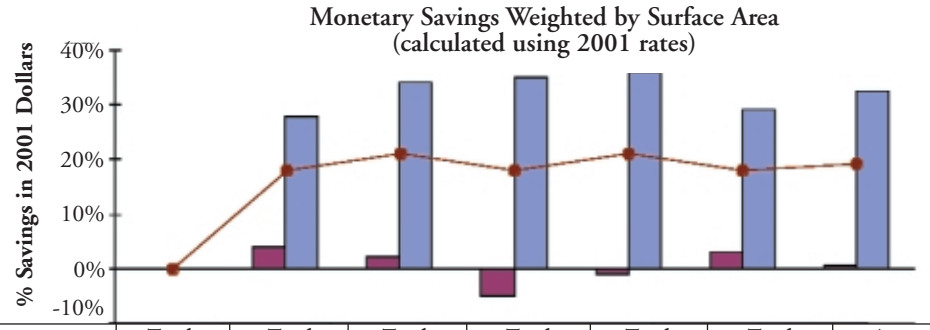
To measure the impact of the various upgrades on energy use during the project's implementation, monthly energy use of each source was weighted in terms of the current surface area of the building. Over the last five years, HCLM's overall energy consumption was 92 percent of 1992–1993 levels, also weighted in terms of surface area (see Figure 1).

By removing the weighting factor and accounting for the 16.8 percent expansion of the facilities, the HCLM was able to keep its energy consumption below 1992–1993 levels up until 2000. However, following a further expansion to the facility size, energy consumption for 2000–2001 exceeded that of the baseline year by more than 13 percent.

Financial Impact

When measuring the financial impact of the energy savings generated from the energy efficiency upgrade program, the results are even more conclusive. Using 1992–1993 consumption figures weighted based on the surface area ratio, and energy factors converted to current rates, the hospital's annual energy bill would have increased by over $360,000 if the energy efficiency measures had not been implemented.

Figure 2. Financial Impact



	Total 1992–1993	Total 1996–1997	Total 1997–1998	Total 1998–1999	Total 1999–2000	Total 2000–2001	Average (1996–1997 to 2000–2001)
Reduction, electricity	0%	4%	2%	-5%	-1%	3%	1%
Savings, natural gas and oil	0%	28%	34%	35%	36%	29 %	32%
Energy savings	0%	18%	21%	18%	21%	18%	19%

Based only on billing data, the HCLM's energy efficiency program has saved over $1 million (undiscounted value), excluding maintenance contracts savings, since 1992–1993 – or 33 percent over the past five years (see Figure 2).

Acknowledgements

The HCLM's energy efficiency program was implemented and managed by Pierre-Klébert Charles. Mr. Charles won an award in the institutional buildings category in the Énergia contest of the Association québécoise pour la maîtrise de l'énergie (AQME). He is the facility operations manager at the HCLM and serves as advisor at the Régie régionale de la santé et des services sociaux de la Montérégie (regional health and social services board of Montérégie), where he is responsible for managing and implementing similar energy efficiency projects for other network institutions in order that they may take advantage of major savings in energy expenditures.

For More Information

Energy Innovators Initiative
Office of Energy Efficiency
Natural Resources Canada
580 Booth Street, 18th Floor
Ottawa ON K1A 0E4
Tel.: (613) 992-3245
Fax: (613) 947-4121
E-mail: info.services@nrcan.gc.ca
Web site: oee.nrcan.gc.ca/eii
or
Charles LeMoyne Hospital
Pierre-Klébert Charles, P. Eng.
Facilities Operation Manager
3120 Taschereau Boulevard
Greenfield Park QC J4V 2H1
Tel.: (450) 466-5000, ext. 2984
Fax: (450) 466-5752
E-mail: Pierre-klebert.charles@rrsss16.gouv.qc.ca

Leading Canadians to Energy Efficiency at Home, at Work and on the Road

The Office of Energy Efficiency of Natural Resources Canada strengthens and expands Canada's commitment to energy efficiency in order to help address the challenges of climate change.

Cat. No. M92-256/2002E
ISBN 0-662-33099-4
(Aussi disponible en français sous le titre : L'hôpital Charles-LeMoyne économise 360 000 $ par an grâce à des améliorations de l'efficacité énergétique)

Recycled paper