Bell Canada's new office park in Montreal makes extensive use of underground parking to help preserve the surrounding green space.

Bell Canada's HQ

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Bell Canada consolidated its corporate headquarters in Montreal in 2008 to a campus on Nun's Island to replace multiple disparate buildings throughout Montreal. The project targeted LEED certification, which it achieved for both phases. There are many environmental benefits and features associated with a LEED project such as reduced potable water consumption, impact of site selection and human environmental concerns. This article touches on those aspects of the LEED certification process that are of concern to projects in cold climates. In particular, a selection of the project-specific advantages and energy benefits of the mechanical systems will be discussed.

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Project Description and Context

Five buildings were constructed in two phases. Phase I consists of three buildings (A, B and C), which are connected via multistory atria. Building A is eight stories and contains mainly office space, with executive offices and conference rooms on the top floor. The bottom floor contains a daycare for the children of campus employees.

Building B is five stories and contains an extensive conference block on the ground floor, as well as light commercial spaces and a data center in the basement. Building C is four stories and contains a major full-service cafeteria on the main floor and a commercial kitchen. The basement contains a fitness center and showers.

Buildings B and C are connected by a four-story atrium that extends around each building. The glazing, which comprises 78% of the overall façade, is concentrated in the atrium and caused the largest architectural penalty in the energy simulations. The buildings form a "U," which encloses a large landscaped courtyard. The entire area under Phase I, that is, buildings A, B and C, as well as the courtyard, is a two-story underground parking lot.

Phase II consists of two buildings (D and E). Building D is the smallest, with only three stories, and contains a smaller cafeteria on the ground floor and a smaller kitchen. It is also the only steel- framed building; the others are concrete. Building E mirrors Building B of Phase I and has some mixed-use space on the ground floor, a data center in the basement, and a bridge that links to Building B of Phase I over a roadway. The entire area under Phase II is also underground parking, and Phase I and II parking garages are linked via tunnels under the roadway.

The new campus includes 1.6 million ft^2 (148 645 m^2) spread over five buildings.

Mechanical Design

The initial concept for the mechanical systems was large rooftop units, several per building. The client was familiar with this type of system at its Toronto campus, but alternatives were explored to provide for optimized energy efficiency. To achieve higher efficiencies and to allow for better use of reclaim heat, the system designers quickly converged on a hydronic solution. Heat-reclaim chillers and centralized fan coils were initially analyzed to maximize cooling system efficiencies, but turndown ratios were of concern to the designers. Given the site's proximity to the Saint Lawrence River, an open-well geothermal system was also explored, but the timeframe of the project did not allow for the required environmental studies, and so it was quickly dropped.

Ultimately, heat pumps in centralized mechanical rooms per floor were chosen as the base system with a single thermal heat transfer loop (as opposed to both chilled water and heating hydronic loops). This allows for decentralized cooling and compartmentalization/isolation of floors from one another in the event that various floors worked extended hours. Also, using heat pumps allowed for the transfer of heat, hydronically, from interior zones to perimeter ones, which permitted heating the large glass façades in the atria with internal heat, rather than generating heat from primary sources.

Loop Design

Once a centralized water loop design was locked in, hybrid heat pumps were chosen as the base mechanical equipment for the heating/cooling. Evaporative fluid coolers provide for heat rejection when the loop temperature is too high, and condensing natural gas boilers are the last stage of heating should heat injection be required. The order of equipment connected to the thermal heat transfer loop was carefully considered to ensure that maximum useful heat was extracted prior to rejecting in summer and all possible recovery/free heat sources were used before generating heat with the boilers.

Due to freezing protection concerns, a 30% ethylene glycol solution was chosen as the hydronic loop media throughout. This concentration provides sufficient protection against bursting, given the heating design conditions of the project.

The loop temperature is modulated based on an indoor/outdoor curve, with low temperature being set to 80°F (27°C) if there is no demand for heating, and going up as high as 104°F (40°C) at design conditions (–20°F [–29°C] outdoors).

Heat Pumps. The hybrid heat pumps allow for direct heating using the ther-

Building at a Glance

Bell Canada

Location: Nun's Island, near Montreal

Owner: KANAM

Principal Use: Corporate Headquarters

Gross Square Footage: 1,606,000

Substantial Completion/Occupancy: Phase 1: 2008; Phase 2: 2009

Total Occupancy: 4,000

mal heat transfer water loop without using compressors. Typical water source heat pumps (WSHPs) are unable to do this. The hybrid heat pumps have a flooded condenser that allows for efficient heat exchange in cooling mode with hydronic loop temperatures up to 120°F (49°C); however, for this project the heating requirements were designed with a loop temperature of 104°F (40°C) maximum. This low-grade heat is sufficiently warm to allow for direct heating—without the use of compressors.

An advantage of these hybrid heat pumps is that the refrigeration circuit is non-reversible, i.e., the condenser is a single-purpose component that can be selected without any trade-off considerations for use as an evaporator in heating season. In heating mode, a three-way valve allows the 104°F (40°C) water to bypass the condenser and feeds directly into a hot water coil inside the hybrid heat pump. The modulating loop temperature allows for smooth transfer of heat to the space, which eliminates discomfort from temperature swings that are sometimes associated with heat pumps in heating mode.

	Average Monthly Outside Air Temperature (°F)	Energy Recovery Ventilator–B1 (cfm)	Power Required to Heat Outside Air to 65°F (MBH)	Recovery from Exhaust Airstream (MBH)	Equivalent Efficiency
November	34.9	11,500	373.8	533	142.6%
December	20.1	11,500	557.7	533	95.6%
January	13.3	11,500	642.1	533	83.0%
February	16.0	11,500	608.6	533	87.6%
March	27.7	11,500	463.3	533	115.1%
April	42.3	11,500	281.9	533	189.1%
					118.8%

Table 1: The average effective heat recovery efficiency over the entire heating season for a typical DOAS exceeds 100%.

A further advantage of the non-reversability of the heat pump is that the refrigerant expansion can be done via a thermal expansion valve as opposed to a capillary tube, and there is no reversing valve, which would normally introduce some unwanted exchange in the system.

The vertical, floor-mounted heat pumps are located in two mechanical rooms on each floor and serve either interior or perimeter zones. There are no reheat coils in the perimeter except for a few electric duct heaters that boost supply air temperature along the four-story glass in the atria. As the glass on each floor is quite high, small electric baseboards were added to the bottom of the glass as a safety, as well as to provide for heating in unoccupied mode when the heat pumps are turned off.

Dedicated Outdoor Air Systems

The strategy of having distributed heat pumps lends itself to having a dedicated outdoor air system (DOAS) to provide the outdoor air requirements for the occupied spaces. Each building has two DOAS units (one lined up with each mechanical room in the core), while Building C has a third unit dedicated to the cafeteria and commercial kitchen space. Each unit provides outside air on each floor that is distributed to the return of each heat pump as per ASHRAE requirements. All long-duration conference rooms (Building B ground floor) are equipped with triple-inlet fan-powered mixing boxes, with the third inlet providing 100% outside air (OA) according to space demand.

The DOAS units also underwent a few iterations before the final design was selected. Cross-contamination concerns, as well as the mid-range efficiencies of heat wheels caused that technology to be bypassed for other options. Reversing solid-core technologies had higher efficiencies, but the cross-contamination concern was still a show-stopper. Ultimately, a custom air handler with active recovery on the exhaust was chosen. The unit has multiple flooded condensers and two different evaporators: one on the outside air, and one on the exhaust. There is no energy recovery in cooling mode on the outside air system, but a high level of heat recovery available on the heating.

Essentially, once the DOAS is no longer needed to cool or dehumidify the outside air and extra heating is required, the unit is able to modulate cooling on the exhaust, bringing the exhaust air down to as low as 36°F (2°C). This provides greater than 100% effective efficiency when considered over the entire heating season, as shown in *Table 1* for a typical DOAS on Building B.

The DOAS provides the first stage of heating for the hydronic loops as there is always a minimum of outside air required in the building.

DHW Preheat

Despite not being able to reclaim any energy for cooling the outside air in the summer months, we are always able to recover heat in cooling and mid-seasons for domestic hot water (DHW) preheating. This strategy was implemented on Building C, which has the highest demand for domestic hot water as the building has both the large commercial kitchen as well as the showers for the fitness center. A combination of passive storage tanks and water-to-water heat pumps are used to preheat the domestic hot water, while standard hot water tanks provide the final stage of heating.

Data Center

The precision computer room air conditioning (CRAC) units in Buildings B and E provide a near-constant heating source. There was some concern that the elevated loop temperatures would be unsuitable; however, in working closely with the manufacturers, operating parameters were adjusted to provide the reliable cooling that the data rooms demanded. The CRAC units originally did not have a redundant cooling source, as the water loop has redundant pumping and redundant heat rejection in the cooling towers. The hydronic loop has since been modified to allow for heat rejection to two different buildings.

Advertisement formerly in this space.

Energy Benefits

It is somewhat difficult to compare the energy profile of this building with others considering that the parking garage accounts for just under 50% of the gross square footage, and there is no separate natural gas or electrical metering for the garage. Also, there is insufficient submetering to allow for reasonable separation of the natural gas consumption between office and garage; however, electrical use has been sufficiently consistent to allow for separation. In *Figure 1*, the electrical energy use intensity (EUI) of the office portion of both Phases I and II is compared.

The campus energy consumption is slightly higher than anticipated, but the building usage is also greater, with several floors operating 24/7. Regardless of the higher consumption, the building operators have a mandate to continually look for opportunities to improve the energy performance of their building, and have made steady and continuous reductions in energy use since the building was commissioned and delivered, as is apparent by the near 10% reduction in EUI over the two-year period analyzed.

The gas use for heating in the office portion of the building is minimal due to the staged loop heating strategies. Trend logs show that the gas boilers seldom go on above outdoor conditions of 14°F (–10°C), which occur less than 700 hours per year.

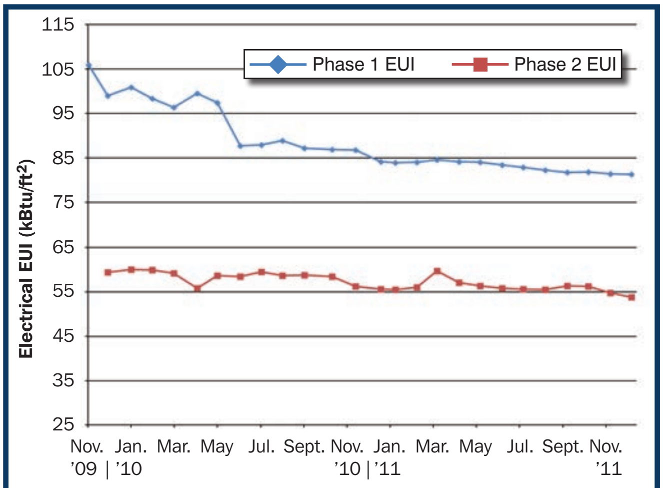

Figure 1: Electrical EUI of Phase I and Phase II.

Opportunities Missed

Garage. At the end of a project, it is customary to review the various decisions made and see if there are opportunities for improvement. At Bell Campus, we feel that there are efficiency synergies that were missed for the underground parking garage. Given that the office towers are so exothermic, it would have been possible to extend the hydronic loops to the parking garage ventilation units to be able to essentially use "free heat" to heat the fresh air. Since the hydronic loops were separated per building and the garage was common to each phase, it was not pursued for the makeup air units.

Another option for integrating the office heat to the garage was to provide hydronic forced-flow units instead of electric ones. This option was not considered due to the increased cost of installing a hydronic piping network in the parking garage over two stories. Perhaps if the parking garage were more compact, this could have been an economically viable design alternative.

Geoexchange systems. If geoexchange systems would have been chosen for this project, they would have coupled very nicely with the common condenser water loop strategy, and the relatively low loop temperatures in heating would have been well suited to geoexchange systems.

Radiant floors. Low-temperature heating is well suited to radiant floors; however, this was not a design strategy considered for this project.

Conclusion

Bell Campus contains some innovative mechanical systems that rely on a hydronic loop to distribute and dissipate heat where and when needed. The hybrid heat pumps can operate in cooling mode with inlet condenser water temperatures up to 120°F (49°C), which allows the condenser water loop to be used for direct heating. Active recovery on the DOAS provides an excellent option for first stage of heating, and has seasonal efficiencies exceeding 100%. ■