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The Earth Rangers Centre

Practical improvements to achieve LEED Platinum EB:O+M

THE PROJECT SITE HAS FEATURES MANY ORIGINAL LOW-IMPACT DESIGN FEATURES AND UPDATES TO GENERATE AND CONSERVE ENERGY [1].

The Earth Rangers Centre [ERC] opened its doors in 2004. Designed to be office space, an animal rehabilitation hospital and long-term animal care facility, this unique building was designed to publicly affirm the environmental mission of its owner, Earth Rangers. Having achieved LEED NC Gold certification, management set the task of reaching LEED Platinum certification for Existing Buildings, Operations and Maintenance [EB:O+M].

BY ANDY SCHONBERGER

GOING FOR GOLD

With the building targeting LEED NC Gold certification, extensive energy modelling was performed in the pre-design phase. Optimization resulted in a 5,500m^2 heavy thermal mass building, with in-slab radiant heating and cooling, displacement ventilation and day lighting throughout. Other features included 16 solar thermal panels for domestic hot water, an integrated wastewater treatment plant, a 930m^2 green roof, a high-efficiency condensing boiler, and earth tube fresh air tempering with enthalpy wheel heat recovery.

Energy modelling predicted consumption to be 63% below the MNECB baseline. Utility bills for 2005 show actual consumption in that first year of occupancy to be 58% better than that benchmark – not quite up to the modelled performance level. Management was tracking this data to ensure that the time, energy and money invested was realized in actual performance. By the end of 2006, fine tuning of systems and operating procedures achieved the design goal of a 67% improvement - a savings of 300,000 kWh/year.

1,000 M^2 OF GREEN ROOF FEATURES 7.5-15 CM OF GROWING MEDIUM, AND MORE THAN JUST SEDUMS [2].

The ERC is situated on lands owned by the Toronto and Region Conservation Authority at the Kortright Centre for Conservation. Site-specific concerns are evident in the design approach including:

- Green and white roofs to reduce the heat island effect
- Bird strike prevention film [earning an innovation credit]
- Rain water harvesting with an on-site wastewater treatment system and waterless urinals
- Low lighting densities with natural day lighting and outside views

LEED NC Gold certification was accomplished in 2006. However, management wanted to further leverage the value of third-party certification, and take the building to the next level, setting a target of Platinum certification under LEED for Existing Buildings, Operations and Maintenance [LEED EBOM].

FROM GOLD TO PLATINUM

The first step was an energy and water audit, whose goal was to provide a realistic blueprint for achieving carbon footprint reductions and energy neutrality, while exploring revenue-generating opportunities [such as Ontario's Feed-in-Tariff program]. The resulting energy and water management plan included metrics such as cost, energy savings, priorities for ease of implementation, and operational impacts expected.

Next came the installation of an 80-point energy metering and monitoring system, along with seven water meters, and nine thermal energy meters. The system provides real-time data through a web interface, and contributed to LEED EB credits that were not attainable otherwise.

In general, the plan to get to net-zero energy, carbon neutrality and LEED EBOM certification involved three related steps:

1. Reduce consumption
2. Convert fossil fuel-powered systems to electricity-powered equivalents
3. Generate on-site electricity with renewables

The first step involved benchmarking the building against other buildings - a process that also confirmed that much of the ERC's energy demand occurred during the heating season, its high thermal mass greatly reducing summer cooling loads. In general, the 2008 consumption data showed the ERC to be in a good position to start step 1.

The audit found many opportunities for consumption savings and operational improvements. A tenant survey conducted at the same time revealed common concerns around thermal comfort and humidity control. Some opportunities were the result of programmatic changes to the building that saw it move from an animal rehab centre to a less energy intensive long-term animal care centre. This enabled some mechanical systems to be downsized or eliminated altogether, while others could be retrofitted or replaced.

Changes included:

- A 44-well ground-source heat pump system to replace the natural gas boiler and chiller/cooling tower combination
- An integrated building automation system to control access, HVAC, lighting and other typically standalone building systems
- Heat pump for domestic hot water makeup coupled with existing solar-thermal system
- Six-zone demand control ventilation, and
- Automation sequence changes

Operationally, commissioning existing systems also provided significant improvement. The domestic hot water system is proof of this. Designed to provide hot water to the animal hospital, the system consists of three preheat tanks, a drain-back tank for glycol coming from the 16 solar thermal collectors, and a service tank. The design relied on consumption of hot water to transfer this pre-heated water to the service tank, which was then "topped up" by the boiler.

The installation of low-flow aerators and low-consumption fixtures meant that the solar thermal preheat was not working as designed. This was identified during commissioning, and resulted in a plumbing and automation sequence change to realize the benefits of the solar thermal system. Energy metering is currently being used to verify the modelled 20,000 kWh per year in energy savings.

Once commissioned, these capital improvements resulted in dramatic energy consumption reductions. Two full years of data show that 90% of natural gas use has been displaced, and the carbon footprint of the building has dropped 40%. 2011 energy consumption was 17% below 2010 levels, contributing to 12 of 18 possible LEED EB energy-related points.

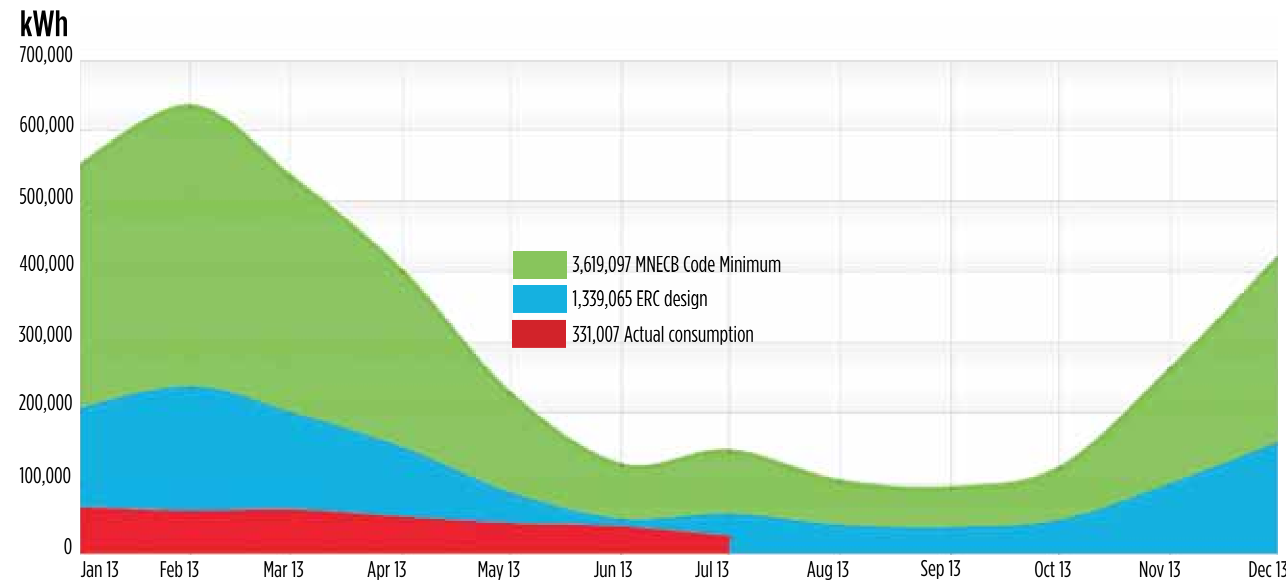
The wastewater treatment plant also saw improvements since NC certification. The ERC is not connected to municipal water supply, and so relies on a well for potable water needs and captured rainwater and treated wastewater for toilet flushing, green roof irrigation, and other non-potable uses.

This system captured all five LEED NC water efficiency credits, but like other building systems, still had room for improvement. Frequent maintenance and higher-than-expected energy consumption were addressed through retrofit of the system in 2009. Energy monitoring was used to verify a 50% reduction in energy consumption, and maintenance time was reduced 90%.

Another change incorporated after NC certification occurred in the restrooms. Originally equipped with waterless urinals, maintenance concerns and occupant feedback resulted in their replacement in 2009 with pint-per-flush units of more traditional design. New 4.5 litre per flush toilets and solar-powered aerators were installed at the same time to reduce water consumption and related energy costs.

The integration of the water and wastewater cycles in the building meant addressing green cleaning at an early stage. Dumping a gallon of traditional bleach down a drain in this building would upset the bacteria processing waste in the basement treatment plant, so green cleaning alternatives have been used in the ERC from the outset. However, LEED EB certification required formal documentation of this program.

Energy efficiency means little to tenants if the space is not comfortable. Many different strategies had been tried to reduce energy consumption, including adjusting the heating and cooling set points, and providing sweaters for staff. This was met with considerable occupant resistance and was soon abandoned.



MNECB COMPARISON [MNECB IS THE REFERENCE MINIMUM ENERGY EFFICIENCY LEVEL OF THE ERC DESIGN]

However, more orthodox commissioning procedures and improvements in automation control meant that proper thermal conditions could be maintained, regardless of season - and thanks to the ground source system - efficiently so. These improvements were documented for the LEED:EBOM certification process.

MORE IMPROVEMENTS AND NEXT STEPS

Bird strike-prevention film was installed on the second floor offices in 2005, resulting in an innovation credit under LEED NC. However, ground floor windows were not protected and in the spring of 2010 migrating robins were striking windows with alarming regularity. In response, ERC science advisor Dr.Scott instituted a program to identify strike zones and species affected so that the appropriate windows could be protected. This operational approach figured into the attainment of a regional priority credit for protecting open habitat.

A couple of very visible changes also occurred on the grounds after the Gold certification. The building initially featured only thermal power generation in the form of solar thermal, but was designed to be solar-PV ready. In 2009 the first 28kW photovoltaic [PV] array was installed, and now generates 32,000 kWh per year, or enough to power the ERC's small data centre.

The larger renovation in 2010 also saw the installation of a second PV array, this one generating up to 90,000 kWh per year from dual-axis tracking arrays. This array follows the sun through axial and elevation changes, increasing the amount of power harvested particularly in the morning and late afternoon. Together, the two arrays have produced about 25% of the ERC's needs in 2012, while also receiving feed-in-tariff [FIT] revenue from the Ontario Power Authority.

Because of the connection to FIT, the system did not qualify for Energy and Atmosphere credits under LEED EBOM.

A 100% renewable energy contract to purchase EcoLogo-certified, low-impact hydroelectric and wind grid power did enable all six renewable energy credits to be obtained.

Energy metering has identified areas for ongoing improvement, such as cooling. The computer room air conditioner [CRAC] was conservatively sized, and after completion of the server racks, it was found to be too big. This shows up in short-cycling of the unit [too-frequent on-off switching], which is inefficient and will cause premature wear of the mechanical components. This $12m^2$ room uses approximately 10% of the building's annual energy consumption, so will be a target when the next round of energy saving initiatives is undertaken in 2013.

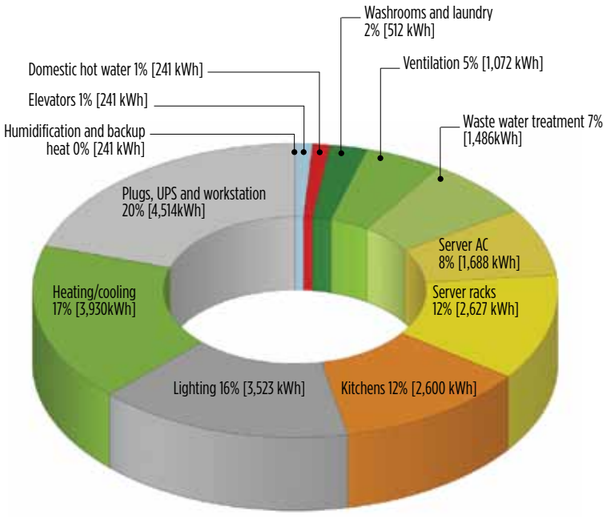
Interestingly, an infrared scan of the building envelope conducted during the LEED EBOM performance period, showed that many of the dual-pane, low-e, argon-filled windows were no longer performing to specification. Some had evidently lost most, if not all, of their insulating gas. Repair of the glazing has not yet proved to be financially viable. The mid-March 2010 scan also showed dramatic heat loss through the revolving door in the reception area, and this door will be replaced in 2013. This scan resulted in an Innovation credit, and will be performed every couple of years to ensure that no building envelope component has failed prematurely.

Some documentation for the LEED EBOM certification was challenging. For example, Earth Rangers had always made efforts to source local foods, both for the staff cafeteria and for its animal ambassadors. Determining, and proving, which foods would qualify as local was time consuming, and the team ended up using free online mapping tools and addresses for individual farms and suppliers to prove the origin of food purchases.

Tracking of ongoing office consumables was less problematic, as integrating one more spreadsheet into the purchasing department's policies was simple, and plenty of eligible products are available from office supply retailers.

So, what is next? There are still opportunities in the 2009 energy and water management plan, although they are more marginal than those undertaken to date. Some were discarded entirely, such as wind turbines which were determined to be uneconomic given the wind regime on the site. Ongoing monitoring is informing priorities for future action. In terms of energy conservation this includes:

- recommissioning the lighting control system to ensure lighting black-out when possible
- integrating access control with building automation [arm-disarm functions] enabling dynamic occupancy scheduling
- metering, monitoring and reducing plug loads, starting with computers and monitors
- investigating the upgrade of the 65-ton ground-source heat pump. *[Continues on page 17]*



ELECTRICITY CONSUMPTION BREAKDOWN

There are still a few remaining gas-consuming loads in the building that could be replaced with their electrically-powered equivalents.

Finally, an additional 70kW fixed array planned for the office roof would bring the percentage solar generation up to 40% annually, and an application is underway through the FIT program's second iteration. Currently, the majority of the facility's utility costs are offset by solar revenues. The net energy cost for 2012 is approximately $14,000, with consumption 81% lower than the MNECB baseline.

Clearly, net-zero energy and water consumption are attainable goals, but will take time and further investment in conservation and generation. The LEED certification process helped to provide a framework to drive this progress, as well as ensure that the building is a comfortable and healthy space for both human and animal occupants. ◀

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THE NATURALLY VENTILATED AND DAY LIT AVIARY FEATURES A 28KW PHOTOVOLTAIC ARRAY [3].