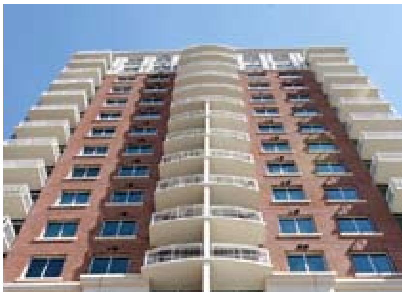

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ONTARIO CLEAN AIR ALLIANCE

Towers of Power

ADVANCING COMBINED HEAT AND POWER IN MULTI-RESIDENTIAL BUILDINGS

Many large multi residential buildings really are small communities in and of themselves. So it increasingly makes sense for these facilities to look at meeting some or all of their power and heating needs internally through combined heat and power (CHP) systems.

Unlike the conventional arrangement where fossil fuel-fired boilers provide hot water and space heating, and electricity is drawn in from large generating stations hundreds of kilometres away, CHP systems essentially position a mini power plant (either an engine and generator set or turbine) that produces both electricity and heat right in the building itself. So instead of using a fuel like natural gas to provide just one service – heat – these systems more efficiently produce both heat and electricity. The result is greater security of supply, utility cost savings and reduced emissions, both due to the higher efficiency fuel usage and avoided transmission line losses for electricity.

The natural gas cogen system in the Villa Colombo Vaughan provides emergency power, electricity and hot water for both space heating and domestic hot water supplies.

With rising fuel and electricity costs, such systems are becoming increasingly attractive for both newly constructed buildings and existing buildings with aging infrastructure. A recent change to Canadian Standards Association (CSA) safety standards for emergency power systems, which are required for all larger multi-residential buildings, has added to the attractiveness of such systems. In fact, a couple of institutions in the Toronto area are pioneering a new approach called Combined Heat and Emergency Power (CHeP).

CHeP comes with big advantages

Tim Short of Enbridge Gas Distribution explains that previous rules required on-site fuel storage, which effectively meant emergency back-up power systems had to be diesel powered, given the impracticality for most users of storing natural gas.

But there there are some serious problems with relying on diesel systems:

- On site diesel fuel supplies are often poorly managed, resulting in fuel degradation or even fuel shortages.
- Diesel systems are often poorly maintained or are started up for only brief test periods, damaging the engines.
- Diesel systems are usually designed to cover essential power needs during a brief building evacuation period (usually two hours), which makes them much less useful during extended poweroutages (in fact, residents are not allowed to return to their units until power is fully restored in such circumstances).
- The insurance industry is starting to recognize the increased risk of on-site diesel fuel storage and the difficulty of refuelling during a widespread black-out.
- And, of course, such systems are a capital cost sink, remaining completely idle and unused other than during an emergency.

Recognizing that the natural gas distribution system is powered independently from the electricity grid, the CSA recently revised its standard to allow for continuous fuel delivery systems in an emergency back-up role. The result, says Short, is a great opportunity for builders, property managers and condominium corporations to realize real cost savings by leveraging their investment in an emergency power system to also meet some of their building's heat and power needs.

For the province as a whole, such an approach opens the door to converting some of the hundreds of kilowatts of power potential locked in emergency systems to efficiently provide clean power, thereby reducing the need for transmission system upgrades and expensive new generation infrastructure, while also reducing overall emissions.

Villa Charities takes the lead

For Villa Colombo Vaughan, a long-term care facility in Kleinburg, a CHeP system made a lot of sense: Evacuating residents during a power outage would be very difficult; there were clear cost savings to be gained in using a continuous feed natural gas system rather than conventional diesel back-up systems and boilers; and the facility had a fairly high heat load (space and water heating) that the system could help to meet. As a new facility, it was also easy to design in a CHeP from square one.

With the help of OZZ Corporation and DDACE Power Systems (DDACE), the facility chose to install a 335 kw Jenbacher gas engine and generator set that provides power and heat drawn from the engine jacket and exhaust heat recovery systems, while also serving as an emergency power system.

With a high heat load and vulnerable residents, a CHeP system made a lot of sense for Villa Colombo Vaughan.

The biggest challenge with the installation, says Jan Buijk of DDACE, was clearly identifying emergency loads and ensuring that these would remain connected or be rapidly reconnected if the system needed to shed electrical loads in the event of a grid power outage. The beauty of the system, he adds, is that once the emergency loads are handled, the system can gradually add back on additional loads in a predetermined order to ensure the facility remains habitable during a longer power blackout. And because the unit is providing both heat and electricity, it also means that the building will remain warm if a power outage occurs during cold weather.

The decision to install a cogeneration system was something that evolved during planning for the 160 resident facility, notes Villa Charities Executive Director Pal Di Iulio. Because most of the 125,000 square foot two-storey structure was constructed as slab-on-grade, there were concerns that first floor residents might find their floors a bit chilly. The solution was to install in-floor heating, which led to the realization that the centre might be well suited to a CHP approach that could meet the increased demand for hot water. The added benefit of being able to forego a $100,000-$150,000 expenditure on a conventional diesel back-up power system while being qualified to receive federal, provincial and municipal incentives sealed the deal, Di Iulio says.

Currently, the system meets all of the facility's hot water needs. And while it is now using an outside laundry service, Villa Colombo was constructed with space and hook ups for a full in-house laundry, making additional demand for hot water and electricity a future possibility, adds Di Iulio.

Villa Charities is hoping that as early as next year, the facility will also be in a position to start selling excess electricity to the grid through the standard offer program, either as a way of offsetting current utility costs or as an additional revenue stream.

Meanwhile, after a period of fine tuning and adjustments, the system has been performing well over the last ten months, says Di Iulio. "So far, so good," he concludes.

CHP Benefits

Security of supply: By being in a position to generate some or all of its own power, a building is less exposed to brownouts or blackouts, especially in areas where the electricity grid is already overloaded.

Reduced costs: The cost savings of in-house electricity and heat generation will likely grow as electricity prices increase.

More robust emergency power: CHeP systems can provide more than just evacuation power and can keep a building habitable during an extended blackout.

Extra revenue generation: There is potential for CHP-equipped buildings to participate in the province's Clean Energy Standard Offer Program or to sell peak power to market aggregators (companies that purchase power from many small suppliers) at premium rates. More information: http://www.powerauthority.on.ca/Page.asp?PageID=1224&SiteNodeID=245

Reduced emissions: By reducing demand for electricity from the provincial power grid, CHP systems reduce the demand for dirty coal power. Every kilowatt of electricity generated by CHP systems is much cleaner than power from coal plants due to their much higher efficiency levels – 80-90% vs. 34% -- and cleaner fuel sources. Such systems can also contribute to better local air quality by reducing NOx emissions from less-efficient conventional boilers or furnaces.

A power revolution in downtown Toronto

When you have an annual $100 million utility bill, finding ways to use energy more efficiently is important. "Even a 1% savings represents $1 million," points out Philip Jeung, Manager, Energy Management for the Toronto Community Housing Corporation (TCHC).

That's why TCHC is about to install a new cogeneration system in its high-rise multi-residential building at 341 Bloor St. Now known as the Senator David A. Croll Apartments, the building is the former Rochdale College, known for its free thinking philosophy and support for radical ideas in the 1960s. But while TCHC is helping to once again break new ground with the cogeneration retrofit, it is doing so with its feet firmly planted on the earth.

When you have a $100 million utility bill, finding ways to use energy more efficiently is important. That's why Toronto Housing is investing in a CHeP system.

Months of detailed design work, data collection and modelling, and structural work has gone into getting ready for the big lift: The hoisting of a 40-foot container holding a 335 kW General Electric (GE) Jenbacher gas reciprocating engine and generator, heat recovery equipment and associated controls onto the top floor of the 16 storey building. The unit, Jeung explains, is expected to provide both base load and emergency power for the 360 units in the multi-family building, while also providing domestic hot water.

One impetus for installing the system, notes Jeung, was the need to replace the building's aging emergency diesel generator. A reliable and robust emergency power source was important to both to the building's residents, some of whom are seniors, and to the commercial tenants that occupy the first two floors. A 24-hour supermarket that is located in the building was particularly interested in ensuring that its fridges and freezers would continue to operate in the event of a blackout, Jeung notes.

Because TCHC has good data on the building's hour-by-hour thermal and electrical loads, sizing the system was relatively straightforward. The unit that TCHC ended up choosing is actually at the small end of the range for reciprocating engines, Jeung notes, even though the building has an above-average hot water demand. But Jeung thinks that as more and more applications along the lines of the TCHC installation proceed, manufacturers like GE are likely to respond with a wider selection of smaller engines.

The goal for the project is to run the cogeneration unit for a minimum of 4,000 to 5,000 hours a year. "We'd like to run it for 6,000 to 7,000 hours a year, but that will depend on the spark gap" — the cost of natural gas to power the in-house system versus the cost of electricity from the utility, says Jeung.

As for putting the unit on top of the building rather than in the basement, Jeung says it was a 50:50 sort of tradeoff: the building's boilers were already located at the top of the building and a basement installation (where the diesel generator is currently located) would have required an insulated exhaust stack to the top of the building. But the expense of reinforcing the top floor and of bringing in a crane capable of lifting the unit to the 16th floor (not to mention closing Bloor Street to traffic) did add substantially to the costs.

Fortunately, says Jeung, the project received support from the Toronto Atmospheric Fund and Natural Resources Canada that helped to offset some of these upfront costs and he now projects a 10-12 year payback for the unit. "We definitely want this project to have economic value," he notes, "we are not just doing this as an experiment."

But TCHC will hold off on making upgrades to other building equipment, like its aging boilers, until it has had a chance to clearly ascertain the cogeneration equipment's contribution to the building's energy performance, he adds. Down the road, Jeung sees the possibility of adding absorption chillers to the mix as well, and points out that the building's immediate neighbour, the Bata Shoe Museum, has a large cooling load that might somehow be cooperatively addressed in the future. The alumni of Rochdale would probably be pleased.

CHP Issues:

Building layout – are electrical, plumbing and HVAC systems easily accessible in one location or located in multiple areas? Is there room to add new equipment alongside existing equipment?

Heat and power load balance: To operate efficiently, the system must be sized so that the heat load is not excessive when power production is at its maximum. Wasted heat means fewer or no savings on operating costs. Adding absorption chilling in summer may be a way to increase system capacity, including power generation.

Emergency power load: In order to replace standalone emergency power generators, the new system must have sufficient power capacity to run required equipment, such as lighting, pumps and elevators. It also has to be able to seamlessly disconnect non-emergency loads while adding emergency loads.

Spark gap: The difference between the cost of producing electricity in a CHP system and the price paid to the local utility for power is often called the "spark gap." Without programs that recognize the significant advantages of distributed generation approaches like CHP (e.g., offsetting peak power loads, reducing transmission system stress, avoided generation costs), and with artificially capped electricity rates in place, some systems may be uneconomic. The Ontario Power Authority's Clean Energy Standard Offer Program will hopefully address many of these issues and provide CHP projects with increased returns and greater economic certainty.

Approvals: New systems may require a Certificate of Approval from the Ontario Ministry of the Environment, despite their clear emission advantages over conventional systems.

Aurora goes green

For the residents of the Highland Green condominium in Aurora, an aging building meant an opportunity to rethink energy use from the ground up. With the help of Enbridge Gas Distribution and local utility Powerstream, building managers undertook a top to bottom energy audit of the two small towers that make up the 150 unit complex.

"We knew we were getting to the point where equipment was going to start to deteriorate," notes building manager James Brown. In fact, the condominium corporation had conducted a previous energy audit that came up with very similar recommendations, but that had simply been gathering dust on a shelf. "Had they moved ahead with the recommendations in that audit, the changes would have paid for themselves by the time the second audit took place," Brown notes.

With renewed enthusiasm for whipping the building's energy performance into shape, the residents moved forward on retrofitting lighting, improving monitoring and controls and completely overhauling the building's mechanical equipment, including an energy hungry water-softening system.

For this condo, replacing the emergency power system wasn't a good fit given its still viable investment in an existing diesel system. But replacing part of the conventional water heating system with a 65 kW Capstone turbine that could produce both hot water and electricity was an attractive proposition. MorEnergy, a company specializing in energy retrofits and innovative financing, offered the condo an easy way to make the upgrade: it would install and run the turbine and accompanying high-efficiency boilers and simply bill the condominium corporation for the power and heat produced. John Nassar, president of MorEnergy, notes that this is an easy way for condo owners to avoid the large capital costs of replacing aging systems and provides building managers with easily understood – and easy to manage – utility costs. "It's really just like paying a utility" for the same services, he notes, except in this case the heart of the utility is right in the building's basement.

The turbine is capable of meeting up to 22% of the building's electricity needs and most of its domestic hot water demand when running full out. Nassar explains that the turbine is actually a more efficient water heater than even the 92% efficient condensing boilers that were installed alongside it because it is always operating at or very close to peak efficiency, compared to the boilers which swing up and down in efficiency as they come on and off. This makes the Capstone system an attractive alternative to conventional boilers, Nassar says. Meanwhile, the electricity produced by the turbine requires only a small additional fuel input. Nassar says that the result is very competitive costs for both heat and electricity, compared to what the condo would be paying under a traditional utility contract.

The Capstone turbine system installed at the Aurora Green Condominium is a good alternative to a conventional boiler. And because the modular system can be easily expanded, it is also a good way to get started with a CHP system.

By working to reduce electricity demand in the building in parallel with installing the new system, the condo managers also ensured that they would get maximum efficiency from the new system. Ensuring that the heat such units produce can be fully used, even in summer, is one of the keys to sizing such systems for maximum efficiency. Trying to meet larger power demands can lead to units that are too large for the heat load.

An option being considered by some buildings, says Nassar, is adding absorption chillers to use more of the heat in summer (absorption chillers use a chemical process to turn heat into cold). The cost of such chillers can be a deterrent, as is the general unfamiliarity of most mechanical engineers or installers with the technology, admits Nassar, but he says MorEnergy has found that a combination of absorption chillers to handle the base cooling load combined with mechanical chillers to deal with short-lived extreme temperatures can be an effective solution.

Because the Aurora building had a good sized equipment room, the new equipment could be installed in parallel with existing equipment during the commissioning period, which made for a hassle-free installation, Brown notes. It also means that in future the condo might be able to take advantage of the modular nature of the Capstone system, where additional turbine units can be easily added, says Nassar.

One of the best parts of the new system, says Brown, is the change from an extremely basic internal monitoring system to a sophisticated externally monitored system that allows adjustments to made automatically or that can generate a phone call or text message to the building manager when more involved adjustments are required. The condo managers also installed – and set up – programmable thermostats in all the building's units.

The residents of Aurora Green are really setting an example for future generations with their energy efficiency efforts and combined heat and power system

One of the interesting things about the Aurora condo is that most residents are 70-plus years of age and most units have only 1-2 occupants. This affected both the residents' perspective on the best way to handle a major capital investment and the general levels of energy use in the building, Brown notes.

As part of the building retrofit, he adds, "I talked a lot to the residents and really tried to communicate what the benefits were." Brown, for example, created a display board with old and new fluorescent tubes to demonstrate the superior energy and lighting performance of the new bulbs to the residents. The result has been a building where seniors are really setting an example for younger generations, something the Town of Aurora recently recognized with a special Civic Award.

The Ontario Clean Air Alliance is a coalition of health, environmental, and consumer organizations, faith communities, municipalities, utilities, unions, corporations and individuals working for cleaner air through a coal phase-out and the shift to a renewable electricity future. Our partner organizations represent more than six million Ontarians.

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