Best Practice: Deep Lake Water Cooling System

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CITY: TORONTO **POLICY AREAS: CLIMATE CHANGE; ENERGY**

BEST PRACTICE

The **Deep Lake Water Cooling system** developed by Enwave Energy Corporation (Enwave) is an innovative cooling system that draws upon Lake Ontario to bring an alternative to conventional air conditioning to cool Toronto's downtown core, including Toronto's Metro Hall. By using the natural low temperature from water in Lake Ontario, Enwave air conditions 29 million square feet of high-rise building space in downtown Toronto, reducing CO2 emissions by 79,000 tons and reducing electricity consumption by 90% compared to conventional chilling.

ISSUE

The City of Toronto is a leading city in the fight against climate change. Toronto has lowered its own greenhouse gas emissions by more than 40% since 1990. Toronto's goal is to reduce greenhouse gas emissions by 80% by 2050.

GOALS AND OBJECTIVES

Main Benefits of Deep Lake Water Cooling:

• Compared to conventional chillers, Deep Lake Water Cooling reduces electricity usage by 90%. This frees more than 61 megawatts from the Ontario's electrical grid.
• Harmful ozone depleting refrigerants, CFC's and HCFC's are reduced.
• 79,000 tonnes of carbon dioxide are removed from the air, which is equivalent to taking 15,800 cars off the road.
• DLWC eliminates a building's exposure to volatile energy markets and potential electricity rate increases because it relies on a renewable energy.
• Customers will avoid increasingly restrictive CFC regulation because DLWC is a CFC-free cooling technology.
• Cleaner drinking water delivered to the City because the water used in the cooling process comes from a deeper part of Lake Ontario.
• Deep Lake Water Cooling reduces noise, pollution and humidity generated by chillers, fans and cooling towers.
• Reduces the strain on our electricity infrastructure, including transmission grids and local distribution networks.
• Enhances Toronto's world-class reputation as a place to live, provides cleaner air for breathing and makes Toronto a leader in sustainable energy.

IMPLEMENTATION

The City of Toronto worked with the Toronto District Heating Corporation (TDHC) (Enwave's non-profit predecessor created by Provincial Statute in 1982) to explore the possibility of using district cooling instead of conventional air conditioning in the redevelopment of the city railway lands. The City remained interested in earlier studies that had identified the potential to harness energy from the lake for cooling. An environmental assessment was completed in 1998 with favorable results. Financial support for advanced engineering work was provided by the Department of Natural Resources Canada in the form of a grant of $1 million - half repayable). Enwave's privatization brought additional equity from shareholders for a total feasibility and engineering design cost of $3.5 million. The Federation of Canadian Municipalities provided a capital works loan from the Green Municipal Fund of $10 million at market rates which has subsequently been fully repaid by Enwave.

Following four years of assessment studies, Enwave began construction in 2002. The following year, intakes were placed out in the lake; additional equipment including switch gear, control systems, heat transfers, and pumps were constructed.
How the system works:

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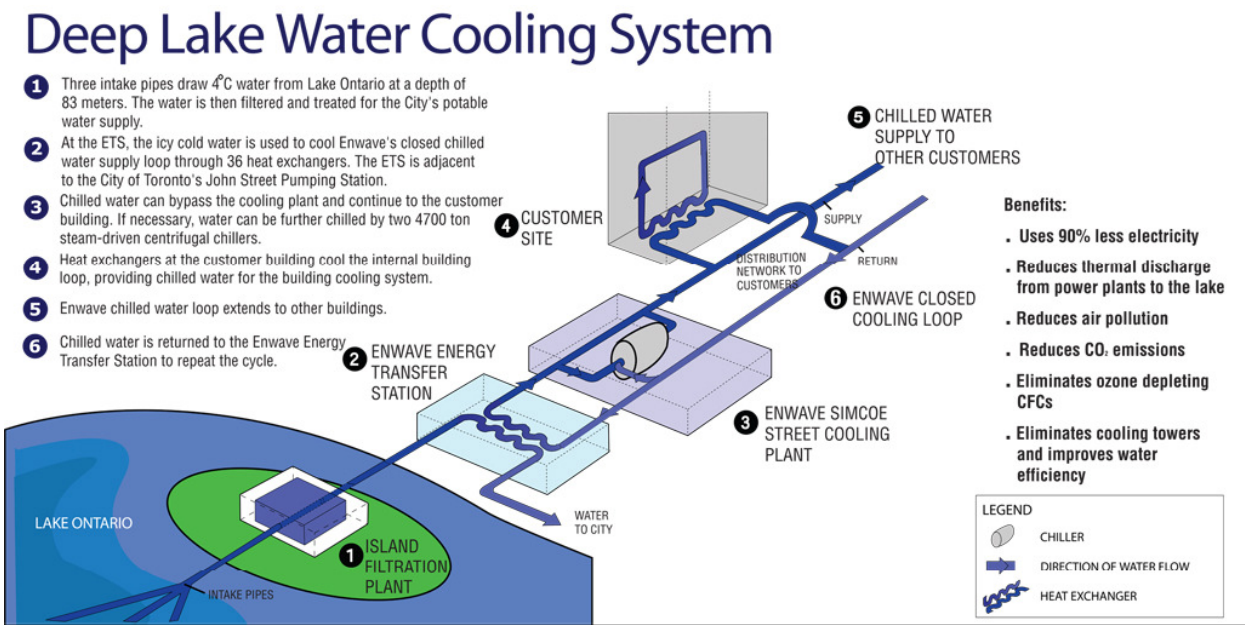
• Three intake pipes draw water (at 4 degrees Celsius) from 5 kilometres off the shore of Lake Ontario at a depth of 83 metres below the surface. Naturally cold water makes its way through the City's Island Filtration Plant to the John Street Pumping Station where Enwave's infrastructure interfaces with the City's water supply system.
• There, heat exchangers facilitate the energy transfer between the filtered, icy cold lake water and Enwave's closed, chilled water supply loop. Water enters the City side of the heat exchangers at 4.4° C and leaves at 12.5° C, warmed 8.1° C by heat transferred from water on Enwave's side of the heat exchanger that has been returned from customers. Physical separation between Enwave's system and the City's system is maintained via heat exchangers that are designed to facilitate the transfer of energy, not water. DLWC uses only the coldness from the lake water, not the actual water, to provide the alternative to conventional air-conditioning.
• The water drawn from the lake circulating on the City side of the heat exchangers then continues on its regular route through the John Street Pumping Station for normal distribution into the City water supply.

Where Is Deep Lake Water Cooling Available?
• Enwave has enough capacity to air condition 30 million square feet of office space in Toronto's downtown financial district.
• The City's Metro Hall was the first municipal facility added to the DLWC system. There are now 60 buildings connected and the owners of another 3 buildings have signed contracts to connect to the Enwave system.



The City of Toronto's Metro Hall was the first municipal building to be retrofitted with this system. Metro Hall located at 55 John Street, is one of the main administrative centres for the City of Toronto. It also houses a Child Care centre and a Library.

The 28 story office tower is about 15 years old and has a total building area of 71,802 m2 (772,870 ft2). The building received The Building Owners and Managers Association (BOMA) award in mid 1990's for energy efficiency. The *pre-retrofit* conditions were as follows: Metro Hall had a centralized cooling plant consisting of two 1,050 ton chillers and thermo cool storage. The chillers used refrigerant CFC R11, which is being phased-out, resulting in a requirement that they either be replaced or upgraded in order to accept an environmentally-friendly replacement refrigerant (i.e., R 123). Although the Metro Hall chillers were in good shape, and about half-way through their useful life, it was prudent to address this issue as soon as possible. Metro Hall was retrofitted for $200 million CAD; this includes intake piping, pumps, heat exchangers, valves, distribution system and building connections.

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COST

- Enwave Energy Corporation owns and operates a district heating and cooling system in downtown Toronto.
- OMERS, Ontario Municipal Employees Retirement Savings System (a $50 billion dollar pension fund with several
- investments in infrastructure projects around the world) and the City of Toronto are the two shareholders of Enwave Energy Corporation. OMERS own 57% and City of Toronto owns 43%.
- The City of Toronto receives from Enwave an annual "Energy Transfer Fee" of approximately $1 million for the use of City Water infrastructure as well as dividends through its minority Shareholder position.
- Due to the sustainable nature of the business, it will provide stable, utility rate returns and cash flow to its shareholders for a very long time.

RESULTS AND EVALUATION

The system uses 85 million kilowatt-hours per year less than conventional cooling systems or roughly the amount of power required to supply 6800 homes a year. The reduction in water consumption from cooling towers is 700 million liters per year less than conventional systems. The estimated reduction in greenhouse gas emissions (carbon dioxide) is 79000 tons a year, or the equivalent of 15800 cars. This estimate is based on displacing coal-fired electricity.

TIMELINE

1988 Toronto hosted the first world conference on global warming

1991 Toronto was the first city to establish an agency devoted solely to climate change.

1997 Environmental assessment commences for DLWC; Toronto District Heating Corporation (TDHC) begins financial restructuring.

1998 Environmental assessment completed for DLWC.

1999 TDHC reorganized as Enwave (private corporation co-owned by the City of Toronto and the Borealis Penco, a wholly owned subsidiary of the OMERS).

2000 Enwave begins second phase of studies for DLWC.

2002 Construction begins.

2003 Intakes placed out in the lake; additional equipment including switch gear, control systems, heat transfers, and pumps constructed.

2004 Enwave begins supplying customers with DLWC.

2006 Metro Hall is connected to DLWC system.

2007 Growing customer base with 60 buildings connected (estimated system capacity – 30 million sq. ft of building space).

2009 DLWC system is showcased at 2009 Copenhagen Climate Summit for Mayors (December 14-17, 2009).

LEGISLATION

N/A.

LESSONS LEARNED

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The Deep Lake Water Cooling project has a maximum capacity of 75,000 tons of refrigeration. The facility was sold out less than 3 years after commencement in 2004 and two years ahead of the projected sales schedule. Given the huge public demand, there is a possibility that Enwave will invest further to expand the system capacity by an additional 25%. Taking a life-cycle cost approach to a customer's needs can help make the business case for district energy. The City and Enwave needed to dispel misconceptions about district energy, project viability, and costs for converting from in-building cooling systems to environmentally friendly DLWC in order to get customers to sign up. Also, nothing like this had ever been done before, so Enwave had to overcome customer apprehensions and concerns. Today, there is broad agreement in the property management and engineering industry that DLWC as a better way to cool buildings in downtown Toronto.

TRANSFERABILITY

A system such as this could applied to a city with a concentrated high cooling demand and a water source of 4 degrees Celsius or cooler is necessary.

CONTACTS

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For the latest information on Deep Lake Water Cooling
visit: http://www.enwave.com/enwave/dlwc/

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This report is based on an exhibition from the 2009 Copenhagen Climate Summit for Mayors Future Cities Exhibition. Innovative initiatives demonstrating how cities around the world are combating climate change were on display. For more information, visit www.climatesummitformayors.dk. Facts and figures in this report were provided by the highlighted city government to New York City Global Partners.