Evolution of a Deep Lake Cooling System
A Brief History...

What? Too far back?
A Brief History...

- Three concrete encased steel pipes extend 3 miles into Lake Ontario, 280 feet below the surface.
- 20 years of marine studies and data had determined that water temperatures at that depth and distance from shore were at a constant temperature of 38°F year round.
- New Intake Pipes replaced the need for the City to install expensive carbon filters to protect water quality.
- New intakes provided security of supply for City water – deeper and N+1 redundancy.
- Water is brought to City’s Island Filtration plant, processed and sent to John Street Pumping Station.
A Brief History...

- DLWC provides chilled water to customers through a heat exchange process that occurs at the JSPS which houses Enwave’s heat exchangers and the City’s potable water pumping infrastructure.
- Enwave’s closed loop chilled water system and the City’s potable water system interface at this location. Water from the two systems never mixes.
- Heat in the 56°F water returned from Enwave’s customers is rejected into the cold 38°F filtered lake water through a heat exchange process that occurs across 36 large heat exchangers.
- After heat is rejected, City water continues onto the Toronto users slightly cooler than 56°F while Enwave’s closed loop water goes to Enwave’s Chilled Water Plant at 38°F.
A Brief History...
A Brief History...
Over 14 kilometers of chilled water piping run beneath the streets of Toronto...

...and 6 MILLION litres of water being circulated
A Brief History...

Enwave - Growth of the Deep Lake Water Cooling System

- **Contract Capacity**
- **Cooling Energy Sold**

### Yearly Sales Growth

- 2001: Initial capacity and sales
- 2002: Incremental growth
- 2003: Steady increase
- 2004: Moderate growth
- 2005: Significant rise
- 2006: Further growth
- 2007: Major expansion
- 2008: Continued growth
- 2009: Steady increase
- 2010: Significant rise
- 2011: Further growth
- 2012: Major expansion
- 2013: Continued growth
- 2014: Steady increase

### Key Observations
- **Annual Sales**: Significant growth from 2001 to 2014
- **Capacity**: Steady increase from 2001 to 2014
- **Energy Sold**: Steady increase from 2001 to 2014

---

### About Enwave

Enwave Energy Corporation specializes in deep lake water cooling systems, offering sustainable and efficient cooling solutions for various industries. The company has seen remarkable growth since its inception, with a focus on expanding contract capacity and increasing the sale of cooling energy.
Selling Capacity vs Cooling Energy

2014 System Loads and Capacity

- Total System Capacity (Tons)
- Deep Lake Capacity (Tons)
- Maximum Cooling System Load (Tons)
- Average System Load (Tons)
How Can We Continue to Grow?

Any suggestions.....PLEASE!!!
Avenues to Growth

- Interruptible Cooling Customers
- Additional Mechanical Cooling Capacity/Plants
  - Chilled Water Trading
  - Raw Water Storage and Bypass
  - Lower Chilled Water Supply Temperature
- New intakes and DLWC Plant
Avenues to Growth

- Interruptible Cooling Customers
  - Additional Mechanical Cooling Capacity/Plants
  - Chilled Water Trading
  - Raw Water Storage and Bypass
  - Lower Chilled Water Supply Temperature
  - New intakes and DLWC Plant
Interruptible Cooling Customers

NOT what we meant by interruptible...
## Interruptible Cooling Customers

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers can reduce their energy consumption by temporarily shutting off non-essential services.</td>
<td>Customers may be inconvenienced by these temporary shutdowns.</td>
</tr>
<tr>
<td>Customers can save money on their energy bills by participating in the program.</td>
<td>May cause disruptions in business operations.</td>
</tr>
<tr>
<td>Customers can increase their chances of not having their power cut off during peak demand periods.</td>
<td>Possible impact on the reliability of critical services.</td>
</tr>
<tr>
<td>Can help reduce strain on the electrical grid during peak demand times.</td>
<td>May lead to increased costs for energy providers.</td>
</tr>
<tr>
<td>Can provide flexibility for managing energy usage.</td>
<td>May require additional infrastructure to handle temporary shutdowns.</td>
</tr>
</tbody>
</table>
Avenues to Growth

- Interruptible Cooling Customers
- Additional Mechanical Cooling Plants
  - Chilled Water Trading
  - Raw Water Storage and Bypass
  - Lower Chilled Water Supply Temperature
- New intakes and DLWC Plant
Additional Mechanical Cooling Plants

We’re not quite back to that....yet
Additional Mechanical Cooling Plants

ENWAVE DLWC SYSTEM

Current Base Capacity ~ 59,500 Tons
## Additional Mechanical Cooling Plants

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower capital cost per unit of capacity compared to available DLWC options for expansion</td>
<td>Higher variable operating costs</td>
</tr>
<tr>
<td>Cooling capacity can be brought to market relatively quickly and can better match the customer growth profile</td>
<td>Fixed costs and resources for operation and maintenance.</td>
</tr>
<tr>
<td></td>
<td>These assets have a shorter useful life, replacement cost in 15 to 25 years</td>
</tr>
</tbody>
</table>
Avenues to Growth

- Interruptible Cooling Customers
- Additional Mechanical Cooling Capacity/Plants
- Chilled Water Trading
- Raw Water Storage and Bypass
- Lower Chilled Water Supply Temperature
- New intakes and DLWC Plant
Chilled Water Trading

And not a ton-hour to be found....
Additional Mechanical Cooling Plants

ENWAVE DLWC SYSTEM

Current Base Capacity = 64,700 Tons
## Chilled Water Trading

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal capital outlay</td>
<td>Most expensive form of cooling to operate, both utilities &amp; maintenance</td>
</tr>
<tr>
<td>• Depreciated value of chiller assets</td>
<td></td>
</tr>
<tr>
<td>• Customer connection</td>
<td></td>
</tr>
<tr>
<td>Addresses market penetration for clients</td>
<td>Complications associated with dispatch and coordination with customer sites</td>
</tr>
<tr>
<td>with existing chiller assets.</td>
<td></td>
</tr>
<tr>
<td>Complicated customer agreement</td>
<td>Complicated customer agreement</td>
</tr>
<tr>
<td>• Utilities</td>
<td>• Utilities</td>
</tr>
<tr>
<td>• Maintenance</td>
<td>• Maintenance</td>
</tr>
</tbody>
</table>
Avenues to Growth

- Interruptible Cooling Customers
- Additional Mechanical Cooling Capacity/Plants
- Chilled Water Trading
- Raw Water Storage and Bypass
- Lower Chilled Water Supply Temperature
- New intakes and DLWC Plant
Well....that certainly won’t do
Raw Water Storage and Bypass

ENWAVE DLWC SYSTEM

Current Base Capacity = 97,200 Tons
# Raw Water Storage and Bypass

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximizes use of available infrastructure</td>
<td>High capital requirements per unit of cooling capacity</td>
</tr>
<tr>
<td>Increases availability of renewable resource</td>
<td>Large step block (20,000 tons) of cooling added, not aligned with customer growth.</td>
</tr>
<tr>
<td>Lowest cost of cooling supply</td>
<td></td>
</tr>
<tr>
<td>• Utility</td>
<td></td>
</tr>
<tr>
<td>• Maintenance</td>
<td></td>
</tr>
</tbody>
</table>
Avenues to Growth

- Interruptible Cooling Customers
- Additional Mechanical Cooling Capacity/Plants
- Chilled Water Trading
- Raw Water Storage and Bypass
- Lower Chilled Water Supply Temperature
- New intakes and DLWC Plant
Lower Chilled Water Supply Temperature

The colder the water the better!
## Lower Chilled Water Supply Temperature

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creates opportunity to increase return temp, this means more DLWC capacity</td>
<td>Adjustment of customers’ chilled water return temperature setpoint</td>
</tr>
<tr>
<td>Alleviates flow capacity restrictions at far end of distribution system</td>
<td>Uncertainty regarding risks associated increasing return temperature setpoint</td>
</tr>
<tr>
<td>Low capital costs per unit of additional capacity achieved</td>
<td>Increased parasitic load from distribution system</td>
</tr>
<tr>
<td>Highly efficient incremental cooling because of additional DLWC energy</td>
<td></td>
</tr>
</tbody>
</table>
Avenues to Growth

- Interruptible Cooling Customers
- Additional Mechanical Cooling Capacity/Plants
- Chilled Water Trading
- Raw Water Storage and Bypass
- Lower Chilled Water Supply Temperature
- New intakes and DLWC Plant
New Intakes and DLWC Plant

R.C. Harris Filtration Plant
New Intakes and DLWC Plant

Existing intakes, Island Filtration Plant

Proposed intakes, RC Harris

Existing intakes, Island Filtration Plant
## New Intakes and DLWC Plant

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substantial growth opportunity, expand Enwave’s footprint within Toronto</td>
<td>High level of capital requirement per unit capacity.</td>
</tr>
<tr>
<td>Low operating and maintenance cost of cooling supply</td>
<td>Limited ability to interconnect/support existing DLWC distribution system.</td>
</tr>
<tr>
<td>Opportunity to learn from lessons from the first DLWC project</td>
<td>Delay between building capacity and customer sales</td>
</tr>
<tr>
<td></td>
<td>Challenges associated with servicing new areas of Downtown Toronto</td>
</tr>
</tbody>
</table>
Questions?
(or we can head out right out for Break?)

Thank you!