Cinergy-Optimira Energy Retrofit of Toronto Arenas and Outdoor Rinks

A Layperson's Guide

This guide has been created to help regular people (citizens of Toronto) to navigate and understand the technical elements of the City of Toronto's building energy retrofit program. In 2002, the City of Toronto approved a contract with Cinergy Solutions (now called Optimira) for $10.2 million to carry out retrofitting of the city's arenas and outdoor rinks with energy efficient measures. The contract has been financed entirely by a loan, interest from which comes out of the city's operating budget. As the operating budget seems to be perpetually lacking, and this is the money which pays for the vital services the city provides, we find this arrangement concerning.

Through Access to Information, CELOS has obtained a copy of most of the May 2005 concept report that was submitted to the city. The report claims that energy savings as a result of the measures implemented by Cinergy Solutions should pay back the cost of the contract within just under ten years. The city of Toronto has excepted the projections of this report as fact:

> Once the implementation of all energy-saving measures is complete, the arenas energy retrofit project will save the City $1.3 million a year on utility costs and reduce the amount of greenhouse gases produced by the City's arenas by 15 per cent.
>
> The total cost of the arenas energy retrofit project is $10,213,000. The project has an estimated 19 per cent reduction in energy and an annual net savings of $1.3 million.
>
> *From http://www.toronto.ca/environment/initiatives/arena_retrofits.htm*

All of this sounds well and good, and may well come to be, but have adequate measures been taken to ensure that such a splendid savings will follow?

This guide will walk through the measures proposed in the 2005 document, using as many observations as possible of work actually done as of 2008. The measures are broken down into categories the following categories:

1. Lighting Measures
2. Building Control Measures
3. Building Insulation Measures
4. Power Factor Correction Measures

Lighting Measures

Illustration 1: Fluorescent Luminaire

The lighting measures proposed are essentially to change the kind of light fixture and bulbs to a lower wattage. Cinergy proposed *existing T12 fluorescent luminaries to be relamped and reballasted with reduced wattage T8 lamps and low ballast factor electronic ballasts*. These are all the fluorescent light fixtures that you see throughout institutional buildings (illustration 1). T12 and T8 refer the kind of bulb. The ballasts are what control the electrical flow to the bulbs. Changing to low ballast factor electronic ballasts does not increase energy efficiency per se. The level of lighting output is proportional to the ballast factor, therefore energy savings are obtained through sacrificing light levels. This reduction in lighting levels is said to be offset by an increase in the Colour Rendering Index, or CRI. CRI is a measure of a light source's ability to reproduce the colours of the objects being lit by that source. In other words, the ability of the light to make things look as they would in natural sunlight.

Illustration 2: Incandescent Bulb

Illustration 3: Compact Fluorescent Bulb

The concept report also states that *select incandescent luminaries will be replaced with screw-in compact fluorescent lamps or replaced with new linear fluorescent luminaries one for one.* In this case, they are referring to the replacement of the kind of bulbs that we have in most households (illustration 2) with the kind you see in the David Suzuki posters (illustration 3). For a given light output, compact fluorescent bulbs use between one fifth and one quarter of the power of an equivalent incandescent bulb. There is no indication of how many or which of the *select* luminaries would get this retrofitting.

Occupancy sensors are included as part of the lighting measures for select arenas. These are similar to the motion detectors that you can get for your house for exterior lighting. The idea of the sensor is to have the lights only come on when someone enters the room. A light switch does the same thing.

Exit signs are to be retrofitted with LED (light emitting diodes) instead of the incandescent lights normally inside such signs. LED's are ideal for this application since the light output of exit signs need not be particularly high. LED's use around one tenth the energy of incandescents under normal conditions.

The final lighting measure is HID dimming. HID stands for High Intensity Discharge. These are the big lights that illuminate the ice surface. Dimming HID lights is not as straight forward as dimming your kitchen lights. It requires a complex dimming system and there are issues with the colour composition of light changing as you reduce the power flow to the bulb.

Building Control Measures

Illustration 4: Building Automation System

The central feature of this category is the Building Automation System, or BAS. The idea here is to hook-up all of the heating and cooling systems of the rinks and arenas to a central computer using a series of temperature sensors connected to a modem (Illustration 4). There is then (theoretically) one operator who controls the wizard from behind the curtain. While our Access to Information adjudicator decided that we ought not to have access to any dollar amounts presented in the concept report, it is the estimation of the author of this guide that this is by far the most expensive element of the entire project. It should also be noted that some arenas and rinks already had existing, locally controlled automation systems in place.

Illustration 5: Temperature Sensor

New temperature sensors were installed in almost every room inside rink buildings (illustration 5). In each building outfitted with BAS, a central thermostat controls the room temperatures on a timed schedule (illustration 6). At Dufferin Rink, the new system was programmed to set the change room temperature to 14 degrees (the default 'unoccupied' temperature) at 9pm. Since the building is often still quite occupied at that time, an override button was installed (illustration 7). At Campbell rink the system was improperly configured, first not turning on at all in -4 degree weather, then later leaving the electric heaters blasting out heat 24 hours a day resulting in air temperatures of over 35 degrees in the office and washrooms.

The largest potential for energy savings exists in better controlling the refrigeration plant (illustrations 8-10). This area is, however, the least well documented or understood (by the author) part of the project. Observational evidence suggests that in some instances, the compressor plant operates continuously during over-night hours and on cold days. Plant operations should be explained to community members by operations managers. A better understanding of what energy saving measures were implemented and how they work is needed. When we asked city officials how much power is used by the refrigeration plant, they were unable to provide an answer. Back of the envelope calculations using formulas from Saskatchewan Power provide the following estimates:

Illustration 6: Override Button

Illustration 7: Thermostat

Load	Size		Operating Time		Energy Consumption
Refrigeration (to get approximate kW, multiply name plate horsepower of motor (hp) x 0.746)					
Compressors	93.25 kW	x	___8____hrs	=	__746.00_kWh /day
Brine pumps	29.84 kW	x	__ 8 ___hrs	=	__238.72_kWh /day

Note that the assumption of 8 hours/day operating time is not founded in any way and the reality could vary widely from this figure. Let's take 8 hours/day to be the low end scenario. If we take utility rates at the current $0.09/kWh, we can estimate that the plant costs roughly $89/day. Multiplied over a 14 week season, that works out to be $8,700 (not including demand charges). Alternatively, if we assume compressor and pump operation for 20 hrs/day, we get an estimate of $17,400 per season.

Illustration 8: Brine Pump

Illustration 9: Compressor

Illustration 10: Expansion Chamber

Building Insulation Measures

This measure involves the installation of weather stripping around building doors (illustration 11). Energy savings from this measure are extremely difficult to estimate and can be highly dependent on traffic levels in and out of the building. In a building that gets a lot of use, weather stripping can be irrelevant if the doors are being opened and closed constantly.

Illustration 11: Weather Stripping

The weather stripping around the main doors at Dufferin Rink have already been worn out, bent or snapped off since their installation from heavy use.

In some arenas, it was proposed that the brine header was to be insulated with 2" of polyurethane foam. This is meant to minimize heat infiltration into the brine that freezes the ice and to prevent corrosion from moisture of the header pipes.

Power Factor Correction Measures

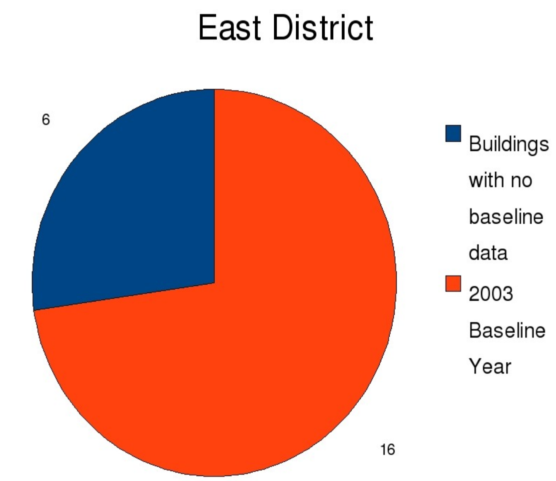
Electricity is distributed using alternating current. This means that the direction of electrical flow reverses itself 60 times a sec (60Hz). For various technical reasons, it is easier to transmit power over long distances using alternating current (as opposed to the direct current supplied from a battery). One side effect of using alternating current is that not of all the available power can be converted into useful work. The total power going into a load (appliance, light etc.) is made up of the actual load (KW) and the apparent load (KVA). For large power users (greater that 50kW), Toronto Hydro charges electrical demand charges for both actual and apparent loads. So bringing the ratio of KVA:KW as close to 1 as possible is advantageous to get the most for the money. This can be achieved by installing a series of capacitors. Such devices, known as capacitive reactance capacitors (KVAr), were installed in select arenas and rinks (illustration 12).

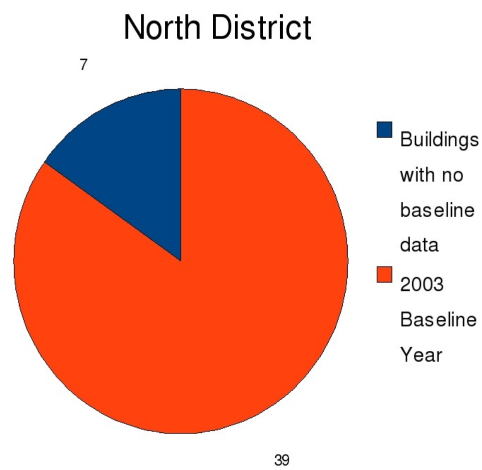
Illustration 12: Capacitive Reactance Capacitors

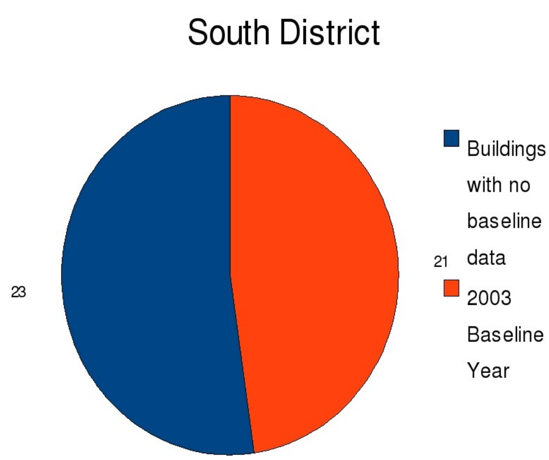
<u>Energy Consumption Monitoring and Savings Verification</u>

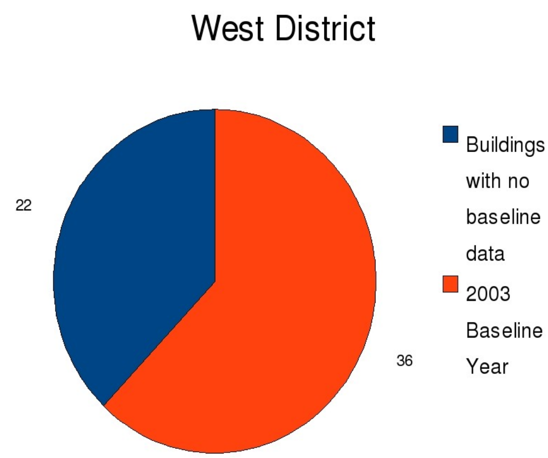
Appendix 1 of the Draft Concept Report is tittled Measurement and Verification Information . It provides baseline consumption figures, estimated saving, and the measurement and verification method for each arena and rink. Many of the facilities will not be verified at all (particularly in the South District) but will rather have an *estimated savings* .While estimated savings is listed under the measurement and verification column, it is actually neither a measurement nor verification. Cinergy reports that since there is insufficient baseline data provided by the city that estimated, or deemed, savings will be taken as the actual savings resultant from the retrofits/redesigns. Figure 1 shows the proportion of buildings for which no (or bad) baseline data was available.

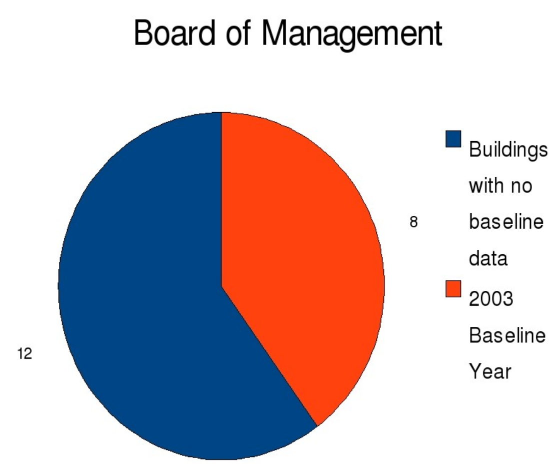
Figure 1: Baseline Energy Data Obtained by Cinergy











Anyone with access to the Hydro Meter at a given facility and a calculator can determine the electrical consumption of that facility over time. While this takes a bit of time and patience to understand, it is not out of the reach of the average person. A fairly simple guide to reading hydro meters for industrial size facilities is presented here: www.saskpower.com/pubs/pdf/**rink**_manual/Section2(s).pdf

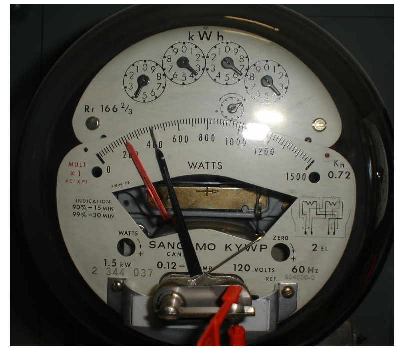


Illustration 13: Hydro Meter at a Toronto Rink

Glossary of Terms contained in the Concept Report

Ballasts Fluorescent lights require a special device to control electricity flow. They are contained in the long rectangular box that holds the fluorescent tube. Magnetic ballasts are an older technology and are associated with the flicker and noisy humming from fluorescent lights. Electronic ballasts are newer and reduce this humming and flickering.

BAS Building Automation System. This refers to a computerized system that controls a building's heating and cooling systems. It is connected to a modem in order to give remote access to the building from a centralized location.

Brine header the large pipe that caries cold brine to the series of smaller brine pipes under the ice. Found in the 'header trench' located along the outside edge of the ice pad that is closest to the refrigeration plant.

CRI Colour rendering index. This is a light source's ability to make things look the way they would under natural sunlight. It is related to the spectral output of the light source. Incandescent bulbs have a low CRI but we have actually grown to find this lighting comforting and is sometimes referred to as a 'warm glow'.

HID High intensity discharge. This is a kind of light bulb that produces light by creating an arc of electricity across a glass tube. These lights require high voltage. These lights are very bright and are used primarily in rinks as the overhead ice surface lights.

Hydro Meter (Illustration 13) - Keeps track of the electricity consumption (in kilowatt hours or kWh) and electrical demand (in kilowatts or kW).

I.E.S.N.A. - Illuminating Engineering Society of North America. IESNA is the recognized technical authority on illumination. They set out standards for lighting levels and technical details for a variety of applications, including recreational facilities.

KVA apparent load. This is what gets measured in industrial applications.

KW actual load. This is the amount of power being used to do work (eg. to crank a compressor).

LED Light emitting diode. These are high efficiency light bulbs. In regular incandescent bulbs almost all of the energy used is dissipated as heat with only a small portion of energy being converted into light. LEDs convert nearly all energy to light.

Luminaries lights. Alternate: light bulbs.

Modem (Illustration 14) A device that transmits and receives data over the telephone line. Is used to remotely control building automation systems.

Occupancy Sensors motion sensors akin to what you may see on the front porch of a house to activate a light. Used to turn on lights when someone is in a room.

Illustration 14: Modem connected to a BAS

T12 those long cylindrical fluorescent lights (the bulb portion)

T8 Just like T12's but a reduced wattage version. T8s are also said to have a better colour rendering index (see CRI).

For more background information about our Access to Information requests on this issue, see:
dufferinpark.ca/research/pdf/Cinergy_1.pdf