EAST BAYFIELD COMMUNITY CENTRE, Barrie ON

80 Livingstone St. E.
Barrie, Ontario L4M 6X9
(705) 739-4225 Facility Supervisor: Jake Veenstra

FEATURES:

- 152,000 sq. ft.
- 25 Meter Pool & small pool
- 2 Arenas with spectator seating
- Full size gymnasium - Air Conditioned
- Fitness Centre
- 3 Meeting Rooms - suitable for activities and meetings. Air Conditioned, Multi-Purpose Rm.
- Childcare Centre

The East Bayfield Community Centre was completed in 2003. The arena is equipped with the Ice Kube Integrated System which is an energy efficient geothermal heat pump which has cold storage under the rink slab. The heat generated during the ice-making process is recovered and use throughout the facility as radiant heating. The modular design of distributed heat pump network system allows adaptation to variable energy needs thereby increasing part-load efficiencies. The modular design also provides redundancy in the refrigeration equipment.

Essentially a mirror image of its sister facility and also located in Barrie ON, the Holly Community Centre was designed with a conventional ice plant system. In a comparison of the two facilities operating costs the following was stated by facility supervisor, Jake Veenstra.

"The overall utility costs at the Easy Bayfield facility in 2008 are $25,000 lower in electricity consumption and $34,000 lower is gas consumption"

"The ice plants maintenance costs at the East Bayfield CC have been $1200.00 in total since opening in 2003, in comparison to conventional refrigeration systems (ammonia) which require an annual maintenance program that costs between $5-7000.00 for a 50hp compressor. Most regulation rinks will have at least 2 compressors."

Jake Veenstra, East Bayfield Facility Supervisor

Port Hawkesbury Civic Centre

Facility Address:
606 Reeves Street
Port Hawkesbury, NS
B9A 2R7

Facility Contact:
Gordie Snook 1-902-625-1610

The **Port Hawkesbury Civic Centre** is a new state of the art facility serving residents, tourists, and the business community of Port Hawkesbury, NS, Canada and the surrounding area. The Centre is a truly "green building" that utilizes design and construction innovations to make it more efficient and easier on the environment and its users. The innovations used in the construction of the Civic Centre makes this truly a "green building" more efficient and easier on the environment and its users.

Through the use of green protocols and innovative technology, the Town of Port Hawkesbury integrated strategic features into complementary systems which optimize the overall energy efficiency of the building. Notably, the **ice-making process for the skating** rink which generates heat that is recycled through a thermal exchanger, providing radiant heat inside the arena. This exchanger currently diverts excess heat to the adjacent geo-thermal storage under the adjacent parking lot and could potentially be reused to provide heat for another building. Another multi-faceted strategy is the day lighting system for the arena which not only reduces the lighting costs by 45%, it reduce the heat generated indoors thus lowering the chilling needs for ice-production.

The arena is equipped with the Ice Kube System which is an energy efficient geothermal chiller which has cold storage in the rink slab. The heat generated during the ice-making process is recovered and use throughout the facility as radiant heating. A site-specific pipe layout design optimizes the efficiency of mechanical pumping reducing the needs from 20-30 hp to 3 hp. The modular design of distributor heat pump network system allows adaptation to variable energy needs thereby reducing part-load inefficiencies. The modular design allows adaptation to variable energy needs thereby reducing part-load inefficiencies.

PORT HAWKESBURY
CIVIC CENTRE

CanmetENERGY

Leadership in ecoInnovation — *Spring 2009*

COMMUNITY ENERGY CASE STUDIES:

Port Hawkesbury Civic Centre
Port Hawkesbury, NS

Community — Heat Pump

Integrated Community Energy System Application

- Energy-efficiency building design, including geothermal system.

Context

- One of the highest profile development projects in recent years in the Strait-Highlands region was the construction of the Port Hawkesbury Civic Centre.
- The facility has been highly regarded worldwide for its sustainable design, including a designation as one of the world's 10 greenest buildings by the US magazine Business Week.
- A key component of this facility is the geothermal heating and cooling system that was installed.

Drivers and Rationale to do the Project

- Port Hawkesbury, a town of about 4,000 residents, needed to replace an aging and inefficient ice arena.

Benefits

- As a result of the earth energy system, it is estimated that the Civic Centre consumes 40-45% less energy that it would with conventional heating and cooling systems.
- Greenhouse gas intensity (kg of CO_2 per m^2) is 73% less than the facility it replaced.

Archetype Characterization

- ***Deinsity:***
  22 full time staff, 1,000 seats at arena events, 2,800 visitors per week
- ***Size:***
  Civic Centre - lot size: 22,663 sq m, building footprint: 7,105 sq m
- ***Mix:***
  Building use - Ice arena, Recreation, Assembly, Restaurant, Retail, and Community Halls

Project Description

Pre-Design

- Prior to beginning the project, the Town of Port Hawkesbury held a one-day municipal planning workshop, focused on sustainable energy and the community, which was attended by politicians and citizens as well as municipal staff and experts.

Design

- Community and major end-user groups actively participated in the design process by sitting on an interdisciplinary team.
- The design of the Civic Centre was guided by green protocols based on Leadership in Energy and Environmental Design (LEED) principles and the Commercial Building Incentive Program[1]. These guidelines provided recommendations for the material selection, energy and water consumption.

Construction

Geothermal Heating and Cooling System

- The arena is equipped with the Ice Kube System which is an energy efficient geothermal chiller which has cold storage in the rink slab.
- The sophisticated heating system works in reverse, so that rather than cooling down the ice; it is removing heat from it.
- The heat generated during the ice-making process is recovered and used throughout the facility as radiant heating.
- Warm water is also circulated through a heat exchanger to heat hot water for the showers, melt snow shavings removed from the ice and melt snow on the sidewalk around the buildings.
- Excess heat is stored in a horizontal earth loop under the parking lot.
- Forced-air heat pumps through the buildings provide heating and air conditioning by drawing or rejecting the heat to the earth loop. That extracted heat keeps the building at a comfortable temperature. To double community benefit, the excess is shared with the high school next door which uses it to heat the swimming pool.

Timeline and Status

2002

In November, the commissioning and design process for this project began

2003

In July, construction began

2004

The building was completed

The official opening was held on November 25th

Layout of the Centre
Source: Port Hawkesbury Civic Centre

[1] http://oee.nrcan.gc.ca/commercial/newbuildings.cfm

Project Description (continued)

Innovative Daylighting for Building Type

- In order to provide natural day lighting for the arena, a band of glass coated with a transparent glaze was integrated at the intersection of the roof and the walls. This material, Solera, by Advanced Glazings evenly distributes direct sunlight which eliminates glare and reduces lighting cost by 45% (estimate).
- This is a North American first for this type of building.
- Electric lights in the centre of the arena are turned off during the day.

Source: OJOLICK ASSOCIATES ARCHITECTS / PLANNERS

Additional Energy Saving Initiatives

- A number of technologies, in addition to the daylighting, were employed to reduce energy consumption. These include high efficiency lighting for other areas of the building, improved thermal insulation in the building envelope, radiant heating to allow reduced air temperatures and automated control systems.

Considerations for Implementation and Ownership

- A fast-track method facilitated by computerized modeling and pre-fabrication reduced the timeline in half which allowed for the building to be ready for occupancy within a short time frame.

Costs and Financing

- The total cost for the Port Hawkesbury Civic Centre was $ 17.3 million.
- The project received over $9 million from government agencies at the federal, provincial and municipal level.
- The FCM Green Municipal Funds approved an estimated grant of $1.09 million, plus a low interest loan of $900,000.
- Furthermore, the community, local businesses and surrounding municipalities contributed $4.5 million to the project through fund-raising.
- An analysis of the incremental costs is: $1,919,516

Roof insulation:	$345,000	Earth Loop:	$197,400
Wall Insulation:	$176,000	Piping for expansion:	$ 20,000
Glazing:	$240,000	Heating System:	$384,716
Ice Making System:	$321,400	LEED Energy Studies:	$235,000

Relationship to Other Best Practices

- In 2006, the Strait-Highlands Region, which includes Inverness County, Richmond County and the Town of Port Hawkesbury, joined the Federation of Canadian Municipalities (FCM) Partners for Climate Protection Program (PCP) with the Strait-Highlands Regional Development Agency (S-HRDA) taking a lead role.
- S-HRDA is working towards completing three milestones under the PCP Program including the creation of a greenhouse gas (GHG) emissions inventory and forecast for the region, setting emissions reduction targets and establishing a Local Action Plan (LAP) to significantly reduce both corporate and community greenhouse gas emissions.

Lessons Learned

- Due to the public nature of the civic centre, the community and major end-user groups were invited to actively participate in the design process through the early establishment of a steering committee. This committee represented local interests within an interdisciplinary team of experts which facilitated a system's approach of the project.

Additional Information

- Additional information may be obtained from the Town's web site at http://www.phcivic.com/

Traditional Ice Plants / HVAC Systems

VS.

IKS Integrated Ice Rink System

Refrigerant	**Conventional Ammonia Refrigerant Ice Plant/ Conventional HVAC System**	**Conventional R22 Refrigeration & Conventional HVAC system**	**IKS Integrated Refrigeration & HVAC System**
	• A Single sheet ice rink with ammonia typically contains 700-1,300 lbs (300-699 kg) in a single refrigerant circuit. • Ammonia is toxic at relatively low levels. • Ammonia is explosive at certain levels of concentration. • Ammonia requires significant safety considerations and precautions (air lock entrance to the mechanical room, oxygen masks, ventilation fans, etc.) • Ammonia does not carry lubricating oils through refrigerant circuit and requires draining oil from the evaporator (chiller) regularly. New oil must be added at a cost of $500 – 1,200 annually, and oil removed must be handled as a hazardous waste product. • A leak with ammonia refrigerant is dangerous. Nearby buildings may need to be evacuated in the event of a leak. Insurance costs are often higher because of the potential liabilities.	• A single sheet ice rink with R22 Typically contains 500 – 1,000 lbs (225 – 450kg) R22 refrigerant in a single refrigerant circuit. • R22 is a CHFC that is rapidly being phased out of use because of the ozone depleting properties. • In the event of a refrigerant leak, there is a potential for losing a significant amount of refrigerant in a system with a single refrigerant circuit. The cost of replacing refrigerant can be significant.	• An integrated geothermal system uses an HFC that is non-ozone depleting and approved under the Montreal Protocol. • A typical system contains a total of 70-100 lbs (30 – 50 kg) in 4-8 separate refrigerant circuits. If one unit has a refrigerant leak, other units are unaffected and the system continues to operate normally at a slightly reduced capacity. The system does not shut down! • Is not toxic and does not require special considerations in the building design to ensure safety of workers or building occupants. • Is designed to operate at low temperatures required to make ice.

<table>
<tr><th></th><th>Conventional Ammonia Refrigerant Ice Plant/ Conventional HVAC System</th><th>Conventional R22 Refrigeration & Conventional HVAC system</th><th>IKS Integrated Refrigeration & HVAC System</th></tr>
<tr><td>Equipment</td><td colspan="2">• Typically large, industrial open compressors are used in conventional systems. These require regular compressor rebuilds and service, adding significantly to maintenance costs.
• Large industrial style compressors require highly trained operations and service personnel, increasing costs of operating systems.
• Conventional chillers require continuous monitoring of system temperatures and pressures by trained personnel. This increases labor costs at the rink.
• Conventional chillers can be serviced and maintained only by specially trained technicians. In smaller communities repairs typically require more time for trained personnel to arrive, and increase maintenance costs.
• Noise and vibration from large industrial refrigeration plants severely restricts the location of the refrigeration plant. In many jurisdictions these systems require ground level, outdoor access. Large quantities of toxic refrigerants require special ventilation considerations for the mechanical room.</td><td>• Is built with "off the shelf" generic components that are readily available and can be serviced by local refrigeration technician.
• Eliminates the need for a stationary engineer or highly trained technician to operate the refrigeration system.
• Small quantities of non-toxic refrigerant, low noise levels and the small size of the modular heat pumps allow a great deal of flexibility in the location of the refrigerant plant.
• The small size of the heat pumps and the elimination of boilers or rooftop units significantly reduces the space requirements for the mechanical system.</td></tr>
<tr><td>System Design</td><td colspan="2">• A conventional system is typically designed with two compressors in a single refrigeration circuit. This increases the number of "on / off" cycles of the system, making the temperature of the ice less consistent.
• A conventional system is not easily integrated into the HVAC system to provide heating, air conditioning or domestic hot water. Adding necessary components to do this is costly.
• Without using an earth loop, a conventional system cannot be used to provide heat when ice is not being chilled. A back-up fossil fuel boiler or other heat source is required.
• Additional equipment required in the building with a conventional refrigeration plant means more equipment that requires service and maintenance. This adds additional long term costs for service and maintenance. Typically one service company provides service for the refrigeration plant, and a second service company is needed for the HVAC equipment. This increases annual maintenance costs.
• Without being connected to the earth loop, additional boilers, furnaces, rooftop units and chillers are required to meet the heating, ventilation and air conditioning needs in the building. Additional mechanical room space is typically required.
• Additional equipment and additional energy sources such natural gas require additional services to the building. Larger electrical transformers, larger gas lines, etc. are typically required to accommodate the additional equipment. This increases initial building costs that is often not reflected as</td><td>• System is completely integrated with the HVAC system. This eliminates the need for fossil fuel boilers or furnaces.
• The refrigeration equipment is used to supply chilled fluid for air conditioning the building or to build ice in ice storage tanks.
• By using the earth loop as an alternate heat source, an integrated geothermal system can provide heating, cooling and hot water for the entire building without using backup fossil fuel or an additional chiller.
• Other nearby buildings are easily connected to the earth loop connected to an integrated geothermal system. This can provide very</td></tr>
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	part of the mechanical system costs. • Without using an earth loop, a conventional refrigeration plant requires the use of a cooling tower to reject excess heat to the atmosphere. Electricity to run fans and pumps is required to reject excess heat to the atmosphere. • Most conventional systems rely on a single brine circulation pump. If there is a pump or pump motor failure the entire facility must be shut down. A typical system uses q 20 – 30 hp circulation pump that may require a lead time of up to several days before it can be installed, necessitating the shutdown of the facility.	efficient heating, cooling, and hot water to other buildings without the cost of an expensive earth loop. • A thermal ice storage system is easily integrated into this type of system to supply peak air conditioning loads or dehumidification capacity to the building. • The modular nature of the integrated geothermal system provides a high degree of flexibility in operation. The same equipment can simultaneously chill ice, provide space conditioning or water heating and dehumidification. • If the building heat requirements are much smaller than the refrigeration loads, the use of an earth loop reduces the size of the cooling tower needed to reject the excess heat to the atmosphere. The temperature of the earth loop can be allowed to increase during the day, and a smaller cooling tower can be used at night when cooler night temperatures allow it to operate much more efficiently, often without the need to waste water for evaporation. • An integrated system is typically serviced by a single service contractor. This simplifies long term service and maintenance costs.

Heat Transfer Fluid	• Calcium chloride salt brine or ethylene glycol is often used in facilities with conventional refrigeration equipment. • Calcium chloride brine is very corrosive unless the pH of the fluid is maintained within specified parameters. This fluid is a potential liability in the event of a leak into the earth under the ice surface because of potential ground water contamination. • Conventional refrigeration systems typically use open expansion tanks, allowing oxygen to be absorbed into the heat transfer fluid. Oxygen in the system accelerates corrosion of metals in the system (circulation pump, chiller barrel, etc.) and increase maintenance costs. An open expansion system necessitates constant monitoring of the heat transfer fluid to ensure it doesn't become corrosive.	• Ethanol, methanol or propylene glycol is used in integrated geothermal systems. These fluids are approved for use in most geothermal systems and applications where there is potential for leaks into the earth under and around a building. • These fluids are much less corrosive for equipment and pumps than salt brines and require much less attention from the system operator. • The integrated system is a closed, pressurized system, minimizing the fluid maintenance requirements.
Rink Floor Design	• Conventional thin floor slab without the mass of "thermal storage buffer" cannot hold ice for more than 12-18 hours. • Ice temperature is affected quickly as refrigeration plant is activated or shut off, making ice temperature inconsistent. • Requires header trench at end of rink, making service of header more difficult, or • Header trench buried under the ice surface makes service to the header impossible in the event of a leak. • Low or medium density pipe with mechanical connections to the header is normally used, increasing potential of leaks of heat transfer fluid. • Connections to the header of a traditional system are typically made with mechanical fittings that can break or leak, increasing the potential for downtime and costly repairs. • Steel or PVC headers is typically used, increasing potential for leaks requiring service. • Thin rink floor design requires the use of a large brine pump (typically 20-30 hp). This increases the kWh consumption of the system and increases the refrigeration load of the ice. • The design of a traditional rink floor requires a header trench at one end of the ice rink. The location of the refrigeration plant can be severely restricted by the header location.	• Floor with "thermal storage buffer" holds the ice for several days in the event of power failure. • Maintains the ice surface temperature very consistently. • Eliminates the need for header trench at the end of the rink or the need for an unserviceable header under the ice surface. • Reduces the size of circulation pumps needed to maintain ice temperature. This reduces electrical consumption and reduces the load on the refrigeration system by 8 – 12 %. • High-density fusion welded 160 psi rated polyethylene pipe is used, reducing potential of leaks. • High-density fusion welded HDPE headers are used, reducing potential for leaks.
System Energy Consumption	• It is difficult to incorporate a large, single purpose chiller into an integrated refrigeration/ HVAC system. There is typically no modulating or staging capability because one or two large compressors and a single circulation pump is used. • Without the use of an earth loop it is virtually impossible to store adequate amounts of heat to be used later in the day. An additional heat source, typically a natural gas boiler, is required to provide the necessary heat when refrigeration plant is not in operation making ice. • Adding necessary controls, piping and heat exchangers needed to use the refrigeration plant to build ice for air conditioning adds significantly to the cost of the mechanical system.	• An integrated geothermal system is designed from the outset to provide all of the refrigeration, heating, cooling, and hot water needs for the facility. The modular nature of an integrated system with a number of smaller heat pumps offers a great deal of flexibility in operation. • The use of thermal storage (in the "thermal storage buffer," the earth loop, hot water storage

	• Without the use of the "thermal storage buffer," the refrigeration plant must be capable of supplying the peak chilling requirements on demand. This requires larger compressors and larger circulation pumps. Without the "thermal storage buffer," the refrigeration plant has no heat source at off peak times and cannot provide heat for the building. Alternate heat sources must be activated, increasing energy consumption and peak electrical demand.	tanks and in some cases ice storage, greatly reduces the peak electrical demands of the system, and eliminates the need for fossil fuel furnaces or boilers. • In some situations it may be possible to connect other nearby buildings, such as community halls, swimming pools, gymnasiums, offices, etc. to a common earth loop. This can reduce the overall cost of installing an integrated system while simultaneously increasing overall system efficiency. This presents the owner with the opportunity of selling heating and cooling energy taken from the ice rink to reduce overall facility operating costs.

Power Consumption
Ice Kube Versus Industrial Plant

The following is for a standard sized facility. Increasing or decreasing the design size would effectively increase or decrease power consumption comparison on a relative basis.

Industrial Plant	Amps	Ice Kube Solution	Amps
(2) 125 HP Compressors	264	(5) 18.75 TR Kubes	170
(1) 40 HP Cold Floor Pump	52	(4) 1.5 HP Kube Pumps	11
(1) 15 HP Condenser Pump	21	(1) 25 HP Cold Floor Pump (VFD Controlled)	27 @ 100%
(1) ½ HP Compressor Cool Pump	1	(1) 15 HP Condenser Pump (VFD Controlled)	21 @ 100%
		(1) 10 HP Cooling Tower Pump	14

Total	338

Total	243

- The Ice Kube solution will draw 95 amps less than an Industrial Plant while running. The peak demand charge will be dramatically decreased by the IKS solutions' ability to start staging compressors of 18.75 TR one by one. This ability to do greater part load cooling will track and maintain better ice temperatures.

Ice Kube Systems

Overview of Public Private Partnerships

A number of regional communities have accomplished significant recreation facilities development projects based on some type of partnering between the municipality and a private entity, and many more communities are actively seeking to do so. Obviously this situation has resulted largely from constrained municipal funding sources and an increasing demand for recreational facilities. These public-private partnerships fall into one of two categories: partnering with a private non-profit entity for use considerations, or partnering with a private for-profit entity.

The earliest examples of private-public partnering are those between a municipality and a non-profit organization for use considerations. The classic example is the partnering efforts of Salve Regina College, which is "landlocked" in Newport, RI, and Middletown, RI Public Schools which has funding challenges and a sprawling athletic campus. The College entered into an agreement with the Town to develop a state of the art sports complex which includes a synthetic turf field, and an all weather track and field facility on school property, and to gift these facilities to the school in return for scheduling considerations. The resultant complex has been a huge win-win for both entities. Going in an opposite direction, the Town of Braintree, MA, in a budget cutting move turned over operations and maintenance of its municipal ice arena to nearby Curry College while retaining significant scheduling rights. There are dozens of similar case studies in which municipalities partner with private, usually non-profit organizations for the development of facilities under joint use agreements.

The more recent evolution of public private partnerships involve partnering between a municipality and a for profit organization. Under these agreements, the commercial for-profit organization is responsible for development, operation and maintenance of a recreation facility (pool, ice arena, fitness center, indoor sports field, tennis facility, etc.) for purposes of making a profit. In a typical agreement the facility is developed on public land which is leased as part of the agreement for a fixed number of years, typically taken as 50 years. In return for the opportunity to develop and operate the facility, the municipality receives some combination of favorable scheduling incentives, a favorable fee/rate schedule, and/or the development of adjacent recreation facilities that are gifted outright to the Town by the developer. Incentives to attract the developer into these municipal partnering opportunities include access to the land, a favorable municipal permitting climate, favorable municipal tax incentives, and most importantly a fixed population of facility users under the agreement.

One of the earliest examples of this type of for-profit partnering was authored by the Town of Devens, MA. Devens was intent on the development of a golf course as part of the Fort Devens redevelopment plan. The Town offered for a 50 year lease a 250 acre tract of land for the development of a championship caliber golf course by a for-profit golf developer. In return the residents of the town were afforded a high quality golf course at a fixed schedule of rates. The resultant Redtail Golf Course is considered to be one of the most outstanding facilities in New England.

There are several for-profit recreation facility developers who have developed synthetic turf athletic fields, usually under a bubble, on public land under a public-private partnership agreement. The municipality can obtain scheduling and fee incentives for these facilities. Alternatively they can require exclusive use of adjacent fields also build by the private partner developer.

Under a third model, the town gets unrestricted use of the field facility during spring summer and fall sports seasons, and turns the field back over to the private partner after fall sports conclude. The private operator erects the bubble and continues to operate the facility for indoor sports for a profit charging market rate fees on public land. A company named O-2 Sports (standing for Outdoor Second Season) has completed two such projects and is currently in the planning stages for potential projects in Canton and Sherborn, MA.

Regardless of which model the for-profit public private partnership follows, in the Commonwealth of Massachusetts, it is required to follow a public bidding process. Prospective recreational facilities developers must respond to an RFP which establishes the development program and standards and the basis of the operational agreement (e.g. terms of the lease). In theory the RFP should also for competitive responses from 3 or more comparable organizations / firms. The RFP must articulate a criteria for award which may include a financial component. The Town may then make an award to that respondent which it deems to be in the Town's best interest given the award criteria as promulgated in the RFP.

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