Esquimalt Sports Centre Energy Audit

Energy Evaluation for:

Esquimalt Sports Centre
1151 Esquimalt Road
Esquimalt, BC

Attention:

Marlene Lagoa
Sustainability Coordinator
Township of Esquimalt

Prepared by:

Jim Groenewoud P Eng.
Coral Engineering Limited
778-829-9711

April 26, 2010

TABLE OF CONTENTS

1. Executive Summary

1.1 Background of the Project

Coral Engineering Limited was asked to provide an Energy Opportunity report on the Esquimalt Sports Centre. This report is to provide a series of strategies and measures which when implemented will reduce each facility's energy consumption and green house gas emissions.

Esquimalt Archie Browning Sports Centre

This 6,041 m^2 (65,000 ft^2) sports centre is comprised of a main floor observation area, a crows nest lounge, a second lounge, a industrial kitchen, some office, several washrooms, a curling rink, an arena, a number of change rooms, a small boiler room, a pair of flood water machine rooms, and a small ammonia plant. This facility currently produces **337.7** Tonnes of CO_2 annually.

The heating and ventilation for this complex is provided by a pair of natural gas fired forced draft boilers. These boilers distribute hot water to various radiators, the DHW (domestic hot water) system, and a number of roof mounted air handlers and one change room air handler. Two of the five air handlers provide 100% outdoor air to the facility and a couple of the others have very high quantities of outdoor air.
The air handler unit that serves the change rooms and runs 24/7. A pair of roof mounted heating ventilation units serves the Crows Nest Lounge and the Sports Centre Lounge also running 24/7 bringing in outdoor air even when the space is unoccupied. A fourth unit serves the kitchen and is electrically interconnected to the exhaust fan so that if the cooking exhaust fan is on so is the 100% make up air unit.
The fifth unit is a make up air unit and serves the lobby and the observation is this unit is 100% outdoor air and heats it to room temperature. This unit is controlled by mercury bulb thermostats and operates even when the facility is unoccupied.

Normalized Annual Utility Costs (Inc taxes) and Consumption for the Archie Browning Sports Complex for 2007 and 2008 are:

Historical Data	Energy Use (GJ)		BEPI (MJ/m2)		BEPI (kWh/ft2)		Cost ($)	
	2008	2007	2008	2007	2008	2007	2008	2007
Gas	5,899	4,797	976	794	25	20	$ 80,100	$ 61,455
Electricity	6,025	5,702	997	944	26	24	$ 41,123	$ 39,149
Total	**11,924**	**10,499**	**1,974**	**1,738**	**51**	**45**	**$ 121,223**	**$ 100,604**

The aim or purpose of this report is to analyze the existing operation this facility and to seek out opportunities to reduce its energy consumption, and to analyze the costs associated with these potential projects. Note that 2008 data was used as the baseline for analyzing project savings, as this data represents current consumption.

At the Sports Centre we recommend the installation of an ammonia gas reclaim system which will extract the heat from the hot ammonia discharge gas and use it to heat a large part of the DHW used at the facility, modify at least three of the rooftop units with demand ventilation control and modify the one make up air unit so that it has access to return air from the space. We will also recommend the use of programmable thermostats to shut equipment down during unoccupied periods. Last we would recommend the installation of VFD's on the brine pumps and the modification of the compressor sequence of operation.

These above mentioned projects represent a tremendous energy and greenhouse gas saving opportunity. We further feel that this energy retrofit proposal presents a highly desirable project for the provincial and federal government's energy conservation objectives. We recommend that the client pursue incentive opportunities from these various governmental agencies.

1.2 Précis of Project

We have identified a number of excellent opportunities to significantly cut the overall energy consumption for of this facility. This accomplishment will require a reasonably sized mechanical retrofit to the heating and ventilation systems and some changes to the ammonia plant.

1.3 Summary Report Table

The costs and benefits associated with this project are summarized below:

Project Summary						
	Capital	Savings	Electricity	Gas	Payback	GHG
	Cost $	$	(kWh)	(Gj)	years	(tonnes)
Control Measures Savings	**$ 21,999**	**$ 7,970**	**81,300**	**324**	**2.8**	**18.3**
Mechanical Savings	**$ 81,950**	**$28,500**	**133,000**	**1495**	**2.9**	**79.2**
Lighting Savings	**$ 47,812**	**$ 9,737**	**115,284**	**0**	**4.9**	**2.5**
Energy Consulting	**10,000**					
Total	**$161,800**	**$46,200**	**329,600**	**1,800**	**3.5**	**100**
Projected Future Usage			**1,344,040**	**4,099**		**238.6**

Note:

1) **The capital costs listed for this project include engineering, implementation and project management, but does not include for hazardous waste removal or seismic upgrades of equipment.**
2) **The capital costs further assume that all of the equipment such as valves and controls are fully operational.**

1.4 Limited Liability

This Proposal is prepared by Coral Engineering Limited for the Township of Esquimalt, BC Hydro, and for grant applications.

This report was prepared by Coral Engineering Limited for the Township of Esquimalt. The material in it reflects our professional judgment in light of the information available to us at the time of preparation. The savings calculations are estimates of savings potential and are not guaranteed. The impact of building changes, building use changes, and staff control changes, new equipment additions, change in the operation procedures, additional computers and weather need to be considered when evaluating savings.

Without the express written permission, any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. Coral Engineering will accept no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Please direct any questions to me directly at 778- 829- 9711. We await your further instructions on this matter and assure you of our co-operation at all times.

1.5 Allocation of Funds

This project has the potential to reduce the **energy footprint** of the facility by **29.3%**.

If all of these recommendations meet with your approval, then we recommend that **$ 161,800** be budgeted for the implementation of capital projects. The Township of Esquimalt may want to have a contingency fund for items and controls that are found to be defective during the energy retrofit.

We estimate that these projects will decrease the electrical load by **(329,600)** kWh or **1143 GJ_e**, while saving **1,800 GJ** of natural gas.
The net result of this is **2,943 GJ** of annual energy savings. These energy saving strategies earn the Township of Esquimalt **99.1 Tonnes** reduction in annual greenhouse gas **(GHG)** emissions. The project will earn the (**29.3%** GHG reduction) and will concurrently reduce the energy consumption by **$ 46,200** each year. Note that these savings are based on 2008 natural gas and electrical energy costs.
The capital costs indicated in this report are firm for a period of two months after which time it may need to be adjusted based on the Labour and Metals index and the possible adjustment in the relationship of the Canadian

2. Customer Information

Archie browning Sports Centre	1151 Esquimalt Road Esquimalt, B.C. V9A 3N6
Contact Information:	Marlene Lagoa, Sustainability Coordinator 1229 Esquimalt Road Phone: (250) 414 7114 Email: marlene.lagoa@esquimalt.ca

Archie Browning Sports Centre

BC Hydro account	**0999 2852 1001**
BC Hydro rate	**1200**
Terasen gas account	**1422828**
Facility type	**Arena and Curling Rink.**
Facility age	**Opened late 1961**
Total floor area and number of floors	**6,041 m^2 / predominantly a single storey building**

3. Administrative Issues

3.1 Sustainability

One of the key functions of this report is to provide measures that can be implemented with the re-use of as much of the existing equipment as possible. This will minimize the capital cost of the retrofit as well as make the facility more sustainable in its energy consumption both embodied as well as direct usage. As part of this process we have included the following features:

- Our design has optimal emphasis on static reclaim; reclaim through the use of super efficient air to air heat exchangers using a minimum of energy to reclaim the heat.

3.2 Green House Gas Reductions

The Township of Esquimalt, Archie browning Sports Centre, can reduce its impact on the environment and reduce greenhouse gas emissions by implementing measures outlined in this opportunity report.
The implementation of the measures in this proposal will reduce the green house gas produced by your facility by 99.1 tonnes of CO_2 emissions.

3.3 Maintenance

The designs of the new systems' recommendations are very sophisticated and require sophisticated control strategies. However, the equipment used is very standard HVAC industry equipment that any qualified refrigeration mechanic can service and maintain.

- There will be some additional filter changing required to keep the systems at peak operation.

3.4 Warranty

The various pieces of equipment have different manufacturer's warranties most of the equipment recommended will have the standard one year warranty.

- Heat pumps have a one year parts and labour warranty.
- Heat pump compressors have a five year parts only warranty.

3.5 Project Benefits

All three facilities can reduce its impact on the environment and reduce green house gas emissions by implementing the recommended measures in this proposal.
Some of the benefits of this implementation are listed below:

- GHG reductions: 100 Tonnes
- Provide a total energy savings of approximately 1,800 Gj/year.
- Reduce the cost of the energy consumption of the facilities: by $ 46,200/year (based on 2008 energy costs).

Implementing the measures suggested will show leadership and environmental stewardship which can be used to teach our younger generation the measures that can be taken towards carbon neutrality.

4. Background Description of Facility, Hardware and Systems

4.1 Mechanical Systems

Archie Browning Sports Centre

Ammonia Plant

There are two independent evaporators located in the ammonia plant one for the Curling rink and the second for the Arena.

The respective brine pump runs if there is a call for cooling by one of the two ice sheets. Brine pumps are sized to have the capacity large enough to handle the largest load. This load occurs at the start of the season when the ice is being laid. The rest of the season the brine pumps could run on part load if they were so configured. Since for most of the season the load is considerably smaller then the peak load, and since these motors only have one speed these motors add an unnecessary load onto the chillers.

As mentioned before there are two under slab electric defrost system some for the arena and one for the curling rink. These heaters come on based on an under-slab temperature and can and will be enabled when the compressors are running. When this occurs it sets a new demand peak for the month costing an extra demand charge from BC Hydro.

There are four compressors in this ammonia plant. The suction piping can be reconfigured so that different compressors can serve the individual ice surfaces. The most common piping configuration of the plant has the compressors on a common suction header and a common discharge header.

Arena and curling Rink Dehumidification

A Munters Desiccant Dehumidifier provides the dehumidification for both the curling and the Arena. The amount of dry air sent to each of the two spaces is manually set and most of the time the curling rink is the largest beneficiary of dry air.

Under Slab heating

There is pyrotechnic under slab heating for both the arena and the curling rink. Neither of these are interlocked with the compressors and most likely run at least once a month concurrent with the compressors setting the demand for the month.

Boiler Plant

A pair of forced draft boilers provides the hot water used to provide the space heating, the DHW (domestic hot water) heating and the flood water heating for this complex. Each boiler has its own circulating pump and each zone has its own pump.

Facility Air Handling Systems

The change rooms are heated by a 100% outdoor air make up air unit. The heat source for this make up air unit is hot water supplied by a pair of forced draft boilers located in the boiler room. This MUA unit runs 24/7 during the winter months even during unoccupied periods. This unit is programmed by a mercury bulb thermostat.

The day of our visit to the site the make up air and exhaust fan in the kitchen were both operating and the lights were on. The make up air is activated when the exhaust fan is manually turned on. Care should be taken to turn these off when the kitchen is unoccupied.

The lobby and observation area are ventilated and heated by a 100% outdoor air make up air units. This unit was installed in the days when smoking was common and the volume of air was needed to wash away the contaminant. Even though smoking is no longer permissible the MUA unit have never been modified for the new rules. Both of these MUA units are controlled by a mercury bulb thermostat. These units run 24/7 even during unoccupied periods.

Sports Centre Lounge and the Crows Nest Lounge are both heated and ventilated by Engineered Air heating ventilating units. The quantities of outdoor air introduced into the facility are high and these units and they are controlled by mercury bulb thermostats. They are running 24/7 and waste a lot of energy during periods when the facility is unoccupied.

The snow melt pit has DHW plumbed to it as well as having an electrical booster to increase the heat on the water poured over the snow. This is costly both on water as well as electricity.

Both the arena and the curling rink have Alumizorb Low E ceilings.

The radiant electric heaters above the bleachers are turned on occasionally for the spectators comfort

All of the washroom and change room exhaust fans run 24/7. All of the air exhausted in replaced through infiltration or the ventilation units. These units can be turned off during unoccupied periods.

Radiant Heaters

We noticed the reflectors on the Radiant heaters are black and are most likely not reflecting a much of the radiant heat onto the patrons, but because of their limited hours of operation and replacement cost would not meet our payback criteria.

4.2 Energy Analysis

Esquimalt Archie Browning Sports Centre.

In Figure 4.2 a, below we notice the facility's demand has a strong seasonality to the load since the facility is off during the summer months of May, June and some of July. The winter peak is consistent at about 400 kW. This reflects the manner in which the compressors are scheduled. They both come on at relatively the same time, creating a peak in demand each month.

Figure 4.2a: Archie Browning Sports Centre Electrical Demand

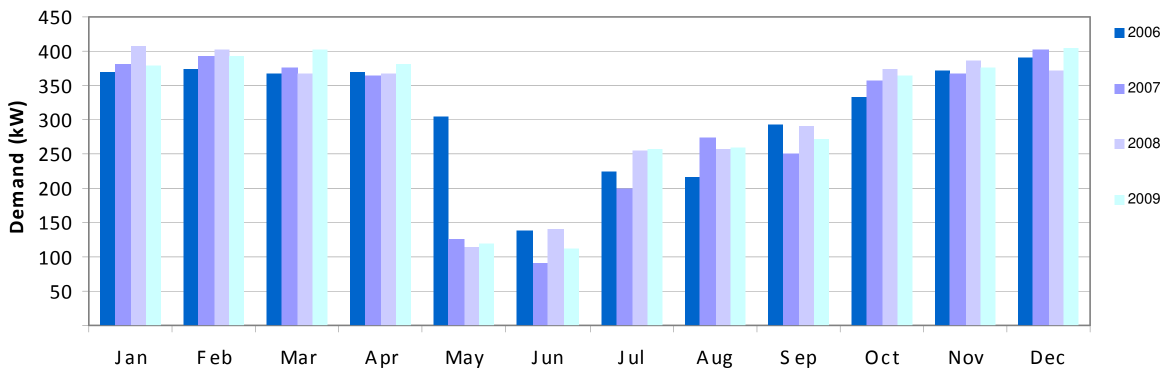
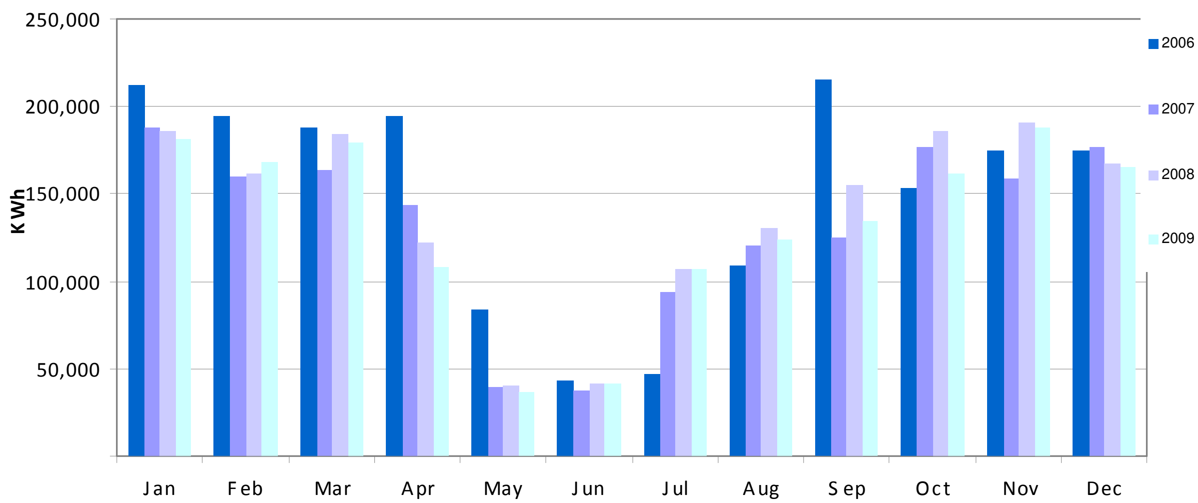
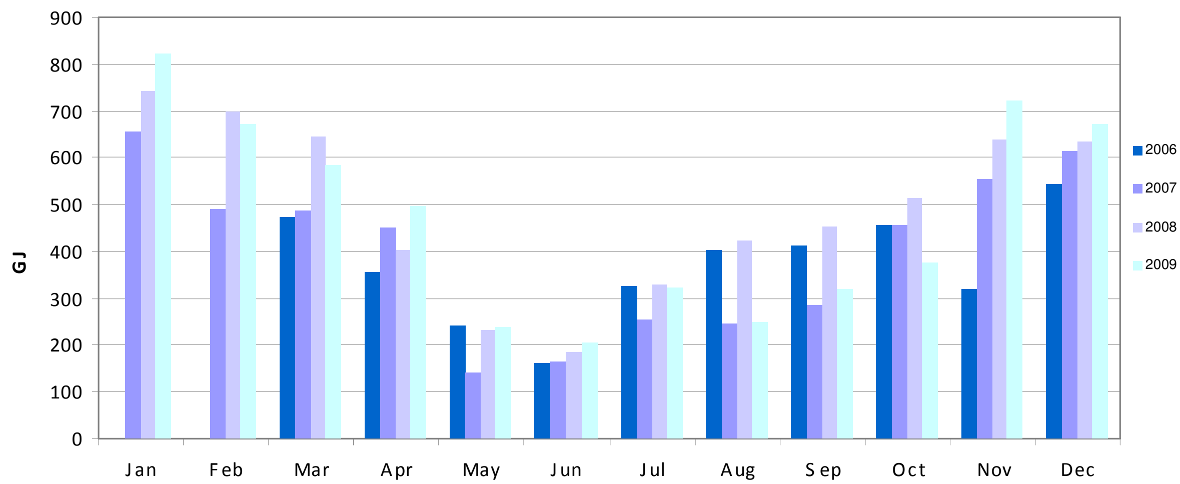


Figure 4.2b: Archie Browning Sports Centre Electrical Consumption



In Figure 4.2 b, above we notice that the monthly electrical consumption is also seasonal with the compressors and brine pump shut down for some of April, May, June and some of July. When we look at the monthly consumption trend, it appears that the monthly consumption is peaked at around 185,000 kWh per month.

Figure 4.2c: Archie Browning Sports Centre Monthly Gas Consumption Profile



In Figure 4.2 c, we can see an increase in the natural gas consumption from year to year, with a generally obvious seasonal heating profile. This variation indicates an opportunity to reduce unnecessary consumption. While annual natural gas consumption appears to vary from year to year, we have assumed an annual baseline of 5680 Gj/year from the year 2009.

Figure 4.2d: Archie Browning Sports Centre Electricity Consumption

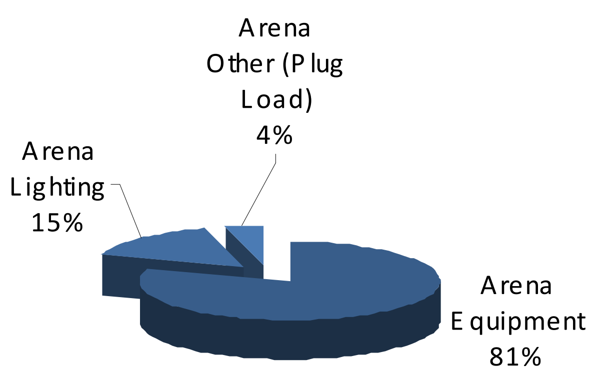
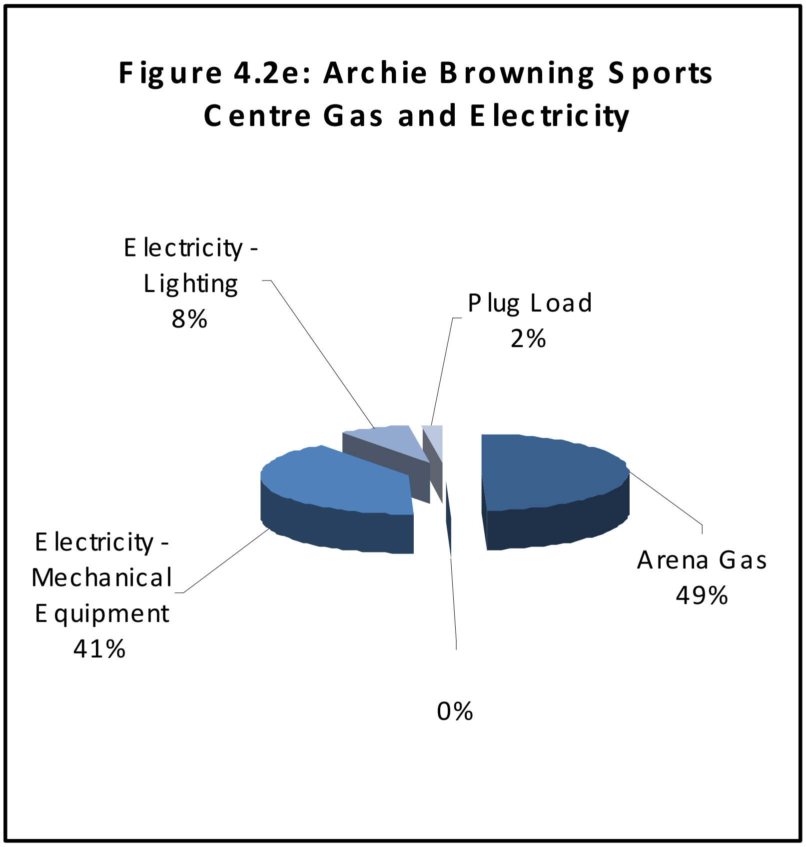


Figure 4.2d. we have analyzed the breakdown of energy consumption by building system in order to estimate the percentage of load each system represents. In this figure we see that the lighting and the arena mechanical loads make up the majority of the electrical consumption.



In Figure 4.2 e the overall energy consumption chart shows our estimate of the energy consumption breakdown associated with electrical usage and building gas heating usage. We see that the estimated natural gas usage accounts for 49% of the energy consumption for this facility, so this will be a focus for our study.

5. Energy Conservation Opportunities

The primary purpose of this study was to identify energy conservation opportunities with a short term payback.

We have identified and analyzed many potential opportunities to save energy and cost by modifying and upgrading mechanical systems at this facility. We will explain these ideas in detail in this section. For financial savings' estimates, we have used a base rate of **$14.65/GJ** for natural gas including an average cost of the BC Carbon Tax of $25 / Ton. For electricity, current BC Hydro electricity rates of $8.34 / kW for demand and $0.0408 / kWh for consumption have been used.

For greenhouse gas estimates, we have used emissions factors of 0.022 kg CO_2e / kWh of electricity in BC. For natural gas we have used the emissions factor of 51.0 kg CO_2e / GJ. Once again, we note for emphasis that we are assuming a baseline for a four year average natural gas consumption of roughly 5,458 GJ per year for all of these savings estimates.

The annual usage that we picked as a baseline for our report is the 2008 consumption of 5,899 Gj /year for the Sports Centre.

5.1 Mechanical Upgrades

The following measures describe a major upgrade to most of the water heating and ventilation systems. The changes we propose will significantly improve the efficiency of the water and air heating.

5.1.1 Sports Centre Hot Gas Reclaim.

Hot gas off of the curling rink ammonia compressors can be reclaimed into a high grade to preheat the DHW system. The tree tanks recommended would also act as storage. There should also be anew additional DHW

line from these tanks to the Flood water room, increasing the capacity of keeping the Flood water up to temperature.
This measure will remove a significant load off the boilers, and reduce the need for the electric boiler located in the flood water machine room.

5.1.2 Installation of VFD on the Brine Pumps.

We recommend the installation of one VFD each of the brine pumps. The town can change the motors now as part of the retrofit or choose to replace the motors with inverter ready motors This will further provide an even source of heat for the domestic hot water system and will provide a more constant temperature for the curling rink and the arena.

5.1.3 Programmable Thermostats and CO2 Demand Ventilation

All of the AHU's presently run 24/7. The addition of programmable thermostats will control the ventilation units hours of operation to better match the occupied periods and un-occupied periods of the facility. Presently the ventilation supplied by these units are set at a minimum position and provide large quantities of ventilation air during un-occupied periods. This is a waste of energy. We recommend the installation of CO_2 controller to control the ventilation dampers and close these dampers when the facility is un-occupied.

5.1.4 Modify the Make-Up Air Unit

We recommend the installation of return air ductwork to the lobby make up air unit so that it has access to return air from the space. We would also include making the recommendations of 5.1.3 to this unit.

5.1.5 Mechanical Opportunity Summary

The above measures are simple and cost effective, requiring very complicated upgrades, requiring additional piping, ductwork, equipment, controls and electrical wiring that we estimate will cost $ 161,800 According to our analysis, this will result in savings of 1,800 GJ/year of natural gas, while saving 329,600 kWh (1143 GJ_e) for a net energy savings of 2,943 GJ. This translates into a net savings of $ 46,200 per year for a simple payback of 3.5 years. Estimated GHG savings from this item alone are 100 tonnes per year.

4.1	**Mechanical Measure Summary**			Savings			
Item	Description	Cost	Payback	$	GJ	kWh	GHG
4.1.1	Hot Ammonia Gas Desuperheater	$ 49,950	3.2	$ 15,600	974	0	49.7
4.1.2	VFD on Brine Pumps	$ 18,000	3.4	$ 5,290		133,000	2.9
4.1.3	R/A to Lobby MUA	$ 14,000	1.8	$ 7,630	521	0	26.6
						0	0.0
						0	0.0
4.1	**Total Mechanical**	**$ 81,950**	**2.9**	**$ 28,500**	**1,495**	**133,000**	**79.2**

We are summarizing the Control Measures summary below:

4.2	**Controls Measure Summary**			Savings			
Item	Description	Cost	Payback	$	GJ	kWh	GHG
4.2.1	Prog. Therm. on AHU's	$ 3,999	8.8	$ 454		11,400	0.3
4.2.2	Demand Controlled Ventilation	$ 15,000	3.2	$ 4,750	324		16.5
4.2.3	Ice Tempering	$ 3,000	1.1	$ 2,770		69,900	1.5
							0.0
							0.0
							0.0
4.2	**Total DDC**	**$ 21,999**	**2.8**	**$ 7,970**	**324**	**81,300**	**18.3**

6. Lighting Opportunity

Lighting audit is under a separate cover.

7. Project Management

These estimated costs include the design costs, and project management time to help direct the implementation of the projects described.

Appendix "A"-1 Mechanical Projects

DDC Controls Measures

4.2.1 **Prog. Therm. on AHU's**

Description	Gas (GJ) Before	Gas (GJ) After	Electricity (kWh) Before	Electricity (kWh) After	Cost	Savings GJ	Savings kWh	Savings $	Comments
AHU-1									The existing units have murcury bulb thermostats. These unts run 24/7 365 days a year. They also have set O/A quantities which are very high and should be controlled to match Occupancy.
AHU-2									
AHU-3									
AHU-4									
Total			36,486	25,050	$ 3,999		11,436	$ 454	
Summary		*Ref*	*Payback*	*GHG*	*Cost*	*GJ*	*kWh*	*$*	
Prog. Therm. on AHU's		4.2.1	8.8	0.3	$ 3,999	-	11,436	$ 454	

4.2.2 **Demand Controlled Ventilation**

Description	Gas (GJ) Before	Gas (GJ) After	Electricity (kWh) Before	Electricity (kWh) After	Cost	Savings GJ	Savings kWh	Savings $	Comments
AHU-1									AHU-1 through AHU-3 have minimum O/A of 100%to 20%. All con be significantly reduced to about 10%. This will reduce the heating loan on the boilers significantly.
AHU-2									
AHU-3									
Total			897	573	$ 15,000	324		$ 4,747	
Summary		*Ref*	*Payback*	*GHG*	*Cost*	*GJ*	*kWh*	*$*	
Demand Controlled Ventilation		4.2.2	3.2	16.5	$ 15,000	324	-	$ 4,747	

4.2.3 **Ice Tempering**

Description	Gas (GJ) Before	Gas (GJ) After	Electricity (kWh) Before	Electricity (kWh) After	Cost	Savings GJ	Savings kWh	Savings $	Comments
Ice Rink Compressor 1			551,667	481,788	$ 4,000		69,879	$ 2,774	Lead and lag compressors are estimated to run 18 hours/day and 1 hour/day, respectively. We estimate that ice tempering will reduce the run hours on the lead compressor, jockey brine pump, cooling tower jockey fan, and condenser pump by 2 hours per day. We will reduce run hours because during the warming of the ice, the compressors will not need to
Summary		*Ref*	*Payback*	*GHG*	*Cost*	*GJ*	*kWh*	*$*	
Ice Tempering		4.2.3	1.1	1.5	$ 3,000	-	69,879	$ 2,774	

Mechanical Equipment Measures

4.1.1 **Hot Ammonia Gas Desuperheater**

	Gas (GJ)		Electricity (kWh)		Cost	Savings			Comments
Description	Before	After	Before	After		GJ	kWh	$	
Hot ammonia gas desuperheater	**1,400**	**426**			$ 49,950	974		$ 15,630	Install three ammonia hot gas desupperheaters DHW preheat tanks in parralel to each other, add to this system a 100% bypass pressure regulator parralel to the tanks. Finally run a new DHW line to the flood water room to eleviate the pressure drop created by the existing 1" line.The hot gas will preheat the shower water, the flood water and the ice pit melt water.
Summary		*Ref*	*Payback*	*GHG*	*Cost*	*GJ*	*kWh*	*$*	
Hot Ammonia Gas Desuperheater		4.1.1	3.2	49.7	$ 49,950	974	-	$ 15,630	

4.1.2 **VFD on Brine Pumps**

	Gas (GJ)		Electricity (kWh)		Cost	Savings			Comments
Description	Before	After	Before	After		GJ	kWh	$	
Install VFD's on Brine Pumps.			244,926	111,632	$ 18,000		133,294	$ 5,291	The 20 and 25 hp brine pumps presently run 24/7 while the ice is in. Fore 8.5 months a year x 726 hours/month x 60% load would save approximately =133294 kWh
Summary		*Ref*	*Payback*	*GHG*	*Cost*	*GJ*	*kWh*	*$*	
VFD on Brine Pumps		4.1.2	3.4	2.9	$ 18,000	-	133,294	$ 5,291	

4.1.3 **R/A to Lobby MUA**

	Gas (GJ)		Electricity (kWh)		Cost	Savings			Comments
Description	Before	After	Before	After		GJ	kWh	$	
Add Return air ducts	579	58			$ 14,000	521		$ 7,633	This unit supplies 100% outdoor air 24/7. The need is about 10% an an occupied bases.
Summary		*Ref*	*Payback*	*GHG*	*Cost*	*GJ*	*kWh*	*$*	
R/A to Lobby MUA		4.1.3	1.8	26.6	$ 14,000	521	-	$ 7,633	

4.1.4 **Pyrontenics on Control**

	Gas (GJ)		Electricity (kW)		Cost	Savings			Comments
Description	Before	After	Before	After		GJ	kW	$	
Pyrotenics enable Control			84		$ 3,000		84	$ 6,124	The Pyrotenics are enabled based on slab temperature. They will be on at least once a month while the compressors are running. Isolate the pyrotnics so that they will not come on simultaniously with the compressors.This saving will occur for at least 9 months a year.
Summary		*Ref*	*Payback*	*GHG*	*Cost*	*GJ*	*kWh*	*$*	
Pyrontenics on Control		4.1.4	0.3	0.0	$ 2,000	-	84	$ 6,124	

Appendix A-2 Mechanical Inventories

ENERGY INVENTORY FORM - Mech Systems

BUILDING NAME: **Archie Browning Sports Centre** **Inventory By:** J Groenewoud

Syste Type	System Name	Equipment Number	Location	Area Served	Mont Profil	hp	Load kW	Load Factor	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Hrs	Annual kWh	% of Total	Schedule	hours / day
									Check Month Op. Hours Apply																
	Rooftop Unit																								
V	Trane hot water air handler	AHU-1	Roof	Lounge	A	1.5	1.1	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	9,802	0.7	24/7	24
V	Trane hot water air handler	AHU-2	Roof	Arena Cross Flow	A	3.0	2.2	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	19,605	1.4	24/7	24
V	Trane hot water MUA	AHU-3	Chage room	Hockey Changerooms	A	0.8	0.6	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	4,901	0.3	24/7	24
V	Trane hot water MUA	MUA-1		Kitchen	A	1.0	0.7	100%	248	224	248	240	248	240	248	248	240	248	240	248	2,920	2,178	0.2	24/7	8
V	Trane hot water MUA	MUA-2		Lobby	A	1.0	0.7	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	6,535	0.5	24/7	24
V	Exhaust fan	EF-1	Roof	Arena	A	0.5	0.4	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	3,267	0.2	Demand	24
V	Exhaust fan	EF-2	Roof	Arena	A	0.5	0.4	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	3,267	0.2	24 \ 7	24
V	Exhaust fan	EF-3	Roof	Zamboni	A	0.3	0.2	100%	93	84	93	90	93	90	93	93	90	93	90	93	1,095	245	0.0	24 \ 7	3
V	Exhaust fan	EF-4	Roof	washroom	A	0.3	0.2	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	1,960	0.1	24/7	24
V	Exhaust fan	EF-5	Roof	washroom	A	0.3	0.2	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	1,960	0.1	24/7	24
V	Exhaust fan	EF-6	Roof	change rm	A	0.3	0.2	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	1,634	0.1	24/7	24
V	Exhaust fan	EF-7	Roof	change rm	A	0.3	0.2	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	1,634	0.1	24/7	24
V	Exhaust fan	EF-8	Roof	change rm	A	0.3	0.2	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	1,634	0.1	24/7	24
V	Exhaust fan	EF-9	Roof	change rm	A	0.3	0.2	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	1,634	0.1	24/7	24
V	Exhaust fan	EF-10	Roof	referee rm	A	0.1	0.1	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	653	0.0	24/7	24
V	Exhaust fan	EF-11	Roof	Kitchen	A	1.5	1.1	100%	248	224	248	240	248	240	248	248	240	248	240	248	2,920	3,267	0.2	daytime	8
	Dehumidifiers																								
D	Dehumidifier	DH-1	Roof	Arena and Curling rink	A2	8.5	6.3	70%	520.8	470.4	595.2	576	669.6	0	0	744	648	595.2	576	520.8	5,916	26,224	1.9	Demand	24
	Plug Loads																								
M	Kitchen		Upstairs	Complex	A	0.0	12.0	80%	310	280	310	300	310	300	310	310	300	310	300	310	3,650	35,040	2.5	Demand	10
M	Elevator		Lobby	Complex	A	5.0	3.7	2%	31	28	31	30	31	30	31	31	30	31	30	31	365	27	0.0		1
M	Walkin cooler		Kitchen	Complex	A	1.0	0.7	50%	372	336	372	360	372	360	372	372	360	372	360	372	4,380	1,634	0.1	Demand	12
M	Computers, pop machines, elevator, etc.			Complex	A	4.0	3.0	180%	558	504	558	540	558	540	558	558	540	558	540	558	6,570	35,289	2.5	Demand	18
	Cooling																								
C	Ammonia Comp 1	C-1	Ice Plant	Arena	A2	50.0	37.3	100%	390.6	352.8	446.4	432	502.2	0	0	558	486	446.4	432	390.6	4,437	165,500	11.7	Demad	18
C	Ammonia Comp 2	C-2	Ice Plant	Arena	A2	50.0	37.3	100%	390.6	352.8	446.4	432	502.2	0	0	558	486	446.4	432	390.6	4,437	165,500	11.7	Demand	18
C	Ammonia Comp 3	C-3	Ice Plant	Arena	A2	50.0	37.3	100%	373.24	337.12	426.56	412.8	479.88	0	0	533.2	464.4	426.56	412.8	373.24	4,240	158,145	11.2	Demand	17.2
C	Ammonia Comp 4	C-4	Ice Plant	Arena	A2	40.0	29.8	100%	217	196	248	240	279	0	0	310	270	248	240	217	2,465	73,556	5.2	Demand	10
C	Cooling Tower Fan	CT-1	Roof	Refrig Plant	A2	20.0	14.9	100%	390.6	352.8	446.4	432	502.2	0	0	558	486	446.4	432	390.6	4,437	66,200	4.7	Demand	18
C	CT Jockey Fan	CT-2	Roof	Refrig Plant	A2	7.5	5.6	70%	108.5	98	124	120	139.5	0	0	155	135	124	120	108.5	1,233	4,827	0.3	Demand	5
	Heating																								
H	Forced draft boiler	B-1	Boiler rm	Heat non arena spaces	H	0.8	0.6	50%	620	504	372	300	248	120	62	62	120	248	420	496	3,572	999	0.1	Demand	20
H	Forced draft boiler	B-2	Boiler rm	Heat non arena spaces	H	0.8	0.6	50%	620	504	372	300	248	120	62	62	120	248	420	496	3,572	999	0.1	Demand	20
	Pumps																								
P	Brine Pump Arena	P-1	Ice Plant	Arena Ice	A2	25.0	18.7	100%	520.8	470.4	595.2	576	669.6	0	0	744	648	595.2	576	520.8	5,916	110,333	7.8	24/7	24
P	Brine Pump Curling	P-2	Ice Plant	Arena Ice	A2	20.0	14.9	100%	520.8	470.4	595.2	576	669.6	0	0	744	648	595.2	576	520.8	5,916	88,267	6.2	24/7	24
P	Evap Condenser	P-3	Ice Plant	Arena Ice	A2	3.0	2.2	100%	477.4	431.2	545.6	528	613.8	0	0	682	594	545.6	528	477.4	5,423	12,137	0.9	24 \ 7	22
P	Condensor Pump	P-4	Ice Plant	Arena Ice	A2	1.5	1.1	100%	390.6	352.8	446.4	432	502.2	0	0	558	486	446.4	432	390.6	4,437	4,965	0.4	24 \ 7	18
P	Ice melt pit recirc pump	P-4	Zamboni rm	Ice pit	A	0.3	0.2	100%	310	280	310	300	310	300	310	310	300	310	300	310	3,650	681	0.0	24 \ 7	10
P	DHW recirc pump	P-5	Boiler rm	Facility	A	0.3	0.2	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	1,634	0.1	24 \ 7	24
P	Circulating pump	P-6	Boiler rm	Heating loop#1	A	0.5	0.4	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	3,267	0.2	24 \ 7	24
P	Circulating pump	P-7	Boiler rm	Heating loop #2	A	0.5	0.4	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	3,267	0.2	24 \ 7	24
P	Circulating pump	P-8	Boiler rm	Heating loop#3	A	0.5	0.4	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	3,267	0.2	24 \ 7	24
P	Boiler pump	P-9	Boiler rm	Boiler pump	A	0.3	0.2	100%	434	392	434	420	434	420	434	434	420	434	420	434	5,110	953	0.1	24 \ 7	14
P	Boiler pump	P-10	Boiler rm	Boiler pump	A	0.3	0.2	100%	744	672	744	720	744	720	744	744	720	744	720	744	8,760	1,634	0.1	24 \ 7	24
	Electric Heat																								
EH	Radiant heat	R-1	Arena	Bleachers	A1		26.0	30%	186	168	186	180	186	0	0	186	180	186	180	186	1,824	14,227	1.0	24/7	6
EH	Radiant heat	R-2	Arena	Bleachers	A1		14.0	30%	186	168	186	180	186	0	0	186	180	186	180	186	1,824	7,661	0.5	24/7	6
EH	Ice pit heater	B-3	Arena	Ice pit	A1		30.0	100%	372	336	372	360	372	0	0	372	360	372	360	372	3,648	109,440	7.7	24/7	12
EH	Slab Ice Plant Electric Heaters	S-1	Ice Plant	Arena Ice	A1		42.0	100%	310	280	310	300	310	0	0	310	300	310	300	310	3,040	127,680	9.0	24/7	10
EH	Slab Ice Plant Electric Heaters	S-2	Ice Plant	Curling ice	A1		42.0	100%	310	280	310	300	310	0	0	310	300	310	300	310	3,040	127,680	9.0	24/7	10
				Sub Total			390.7														257,716	1,415,212			
L	Lighting						48.4															258,573			
	Plug	71,990																				0			
																					Total	1,673,785			
																					actual	1,673,640			

Code	Totals by System Type	hp	kW	Hrs	kWh	
V	Ventilation	12	9	120,815	64,179	5
C	Cooling	218	162	21,248	633,727	45
D	Dehumidification	9	6	5,916	26,224	2
P	Pumps	52	39	74,252	230,405	16
H	Heating	2	1	7,144	1,999	0
M	Plug	10	19	14,965	71,990	5
EH	Electric Heat	-	154	13,376	386,688	27
	Total	301	391	257,716	1,343,222	100

Appendix A3 Utility Information

Archie Browning Sports Centre

Read Date	Days	Consumption (kWh) from meter read	Daily Average (kWh/day)	Demand (kW)	Amount ($)	Power Factor (%)	PF Surcharge ($)
15-Dec-09	28	165600	5914	405	10206.45	93	0
17-Nov-09	33	187920	5695	376	10887.48	92	0
15-Oct-09	29	161640	5574	365	9703.03	91	0
16-Sep-09	30	134640	4488	272	7795.11	90	0
17-Aug-09	33	124200	3764	259	7397.42	88	0
15-Jul-09	30	106920	3564	258	6657.02	89	0
15-Jun-09	31	41040	1324	111	2760.08	89	0
15-May-09	29	37080	1279	118	2572.25	91	0
16-Apr-09	30	107640	3588	380	7302.76	92	0
17-Mar-09	32	179640	5614	403	10300.9	93	0
13-Feb-09	28	168120	6004	393	9762.2	94	0
16-Jan-09	32	181440	5670	379	10177.86	93	0
15-Dec-08	28	167760	5991	372	9577.77	93	0
17-Nov-08	31	190800	6155	385	10597.61	92	0
17-Oct-08	31	185760	5992	374	10308.55	92	0
16-Sep-08	32	155160	4849	290	8414.27	91	0
15-Aug-08	30	130320	4344	256	7153.08	93	0
16-Jul-08	30	107280	3576	255	6230.99	94	0
16-Jun-08	32	41760	1305	141	2743.48	100	0
15-May-08	29	39960	1378	115	2561.72	99	0
16-Apr-08	30	122400	4080	367	7521.7	97	0
17-Mar-08	32	184680	5771	367	9594.14	95	0
14-Feb-08	28	161640	5773	403	9009.29	96	0
17-Jan-08	34	186120	5474	408	10316.33	96	0
14-Dec-07	28	159120	5683	402	8988.71	96	0
16-Nov-07	29	161640	5574	366	8806.78	94	0
18-Oct-07	31	177120	5714	358	9327.66	95	0
17-Sep-07	32	124920	3904	250	6534.48	93	0
16-Aug-07	30	120600	4020	275	6563.93	95	0
16-Jul-07	32	93600	2925	201	4979.91	94	0
15-Jun-07	30	37800	1260	91	2252.61	99	0
16-May-07	29	39240	1353	127	2450.93	99	0
17-Apr-07	33	143640	4353	365	8122.9	95	0
15-Mar-07	29	163080	5623	376	8937.84	96	0
14-Feb-07	28	159840	5709	392	8925.75	96	0
17-Jan-07	34	187920	5527	381	10528.09	97	0
14-Dec-06	28	160560	5734	390	9197.23	96	0
16-Nov-06	30	174600	5820	371	9590.09	95	0
17-Oct-06	29	153000	5276	334	8462.91	94	0
18-Sep-06	47	215640	4588	293	11773.96	93	0
2-Aug-06	33	108720	3295	216	5820.29	94	0
30-Jun-06	29	46800	1614	225	3372.29	97	0
1-Jun-06	30	42840	1428	137	2602.12	98	0
2-May-06	32	83880	2621	305	5364.28	97	0
31-Mar-06	29	194760	6716	370	9992.14	97	0
2-Mar-06	29	188280	6492	366	9720.13	97	0
1-Feb-06	29	194760	6716	373	10015	96	0
3-Jan-06	32	212040	6626	370	10636.81	96	0

Terasen Gas Utility information

Date	Consumption in GJ	Metered Charge	Unmetered Charge	Temperature
06-Mar	474.6	5712.88	111.52	6.48
06-May	356.9	4296.11	111.52	9.21
06-May	242.6	2920.23	111.52	12.83
06-Jun	161.9	1948.84	111.52	16
06-Jul	327	3901.66	110.54	18.17
06-Aug	402.9	4807.27	110.54	16.66
06-Sep	412.6	4923	110.54	14.52
06-Oct	456.8	5450.38	110.54	10.13
06-Nov	317.4	3787.12	62.64	8.06
06-Dec	542.6	6474.12	110.54	3.75
Total 2006	**3695.3**	**44221.61**	**1061.42**	**11.581**

Date	Consumption in GJ	Metered Charge	Unmetered Charge	Temperature
07-Jan	655	8029.93	110.54	3.44
07-Feb	491.1	6168.19	110.54	5.11
07-Mar	485.8	6101.63	110.54	6.17
07-Apr	448.6	5634.39	110.54	8
07-May	142.5	1789.79	110.54	10.41
07-Jun	163.8	2057.32	110.54	13.67
07-Jul	253.7	3186.46	110.54	16.97
07-Aug	246.5	3096.03	110.54	16.83
07-Sep	285.6	3593.87	110.93	15.62
07-Oct	456.6	5755.18	110.93	10.48
07-Nov	553	6970.25	110.93	8.31
07-Dec	614.3	7742.89	110.93	3.29
Total 2007	**4796.5**	**60125.93**	**1328.04**	**9.858333333**

Date	Consumption in GJ	Metered Charge	Unmetered Charge	Temperature
08-Feb	1442.6	18712.41	219.9	3.69
08-Mar	643.8	8464.32	109.95	5.69
08-Apr	402.6	5293.15	109.95	5.8
08-May	230.2	3026.54	109.95	8.48
08-Jun	183.8	2416.5	109.95	13.41
08-Jul	330.3	4434.48	109.95	16.57
08-Aug	423.2	5784.66	109.95	16.77
08-Sep	451.8	6175.59	109.95	15.91
08-Oct	515.4	7044.92	109.95	11.48
08-Nov	639	8734.41	109.95	9.03
08-Dec	636	8693.4	109.95	5.32
Total 2008	**5898.7**	**78780.38**	**1319.4**	**10.19545455**

Date	Consumption in GJ	Metered Charge	Unmetered Charge	Temperature
09-Jan	821.3	11468.28	109.95	1.81
09-Feb	672.8	9660.73	109.95	3

09-Mar	585.5	8407.19	109.95	4.06
09-Apr	495.7	7117.75	109.95	6.84
09-May	239.1	3433.23	109.95	9.83
09-Jun	205.1	2945.03	109.95	15.48
09-Jul	321.5	4658.39	109.95	16
09-Sep	567.4	8295.23	219.89	17.25
09-Oct	377.4	5517.47	109.95	11.93
09-Nov	723	10570.04	109.95	8.21
09-Dec	670.9	9808.36	109.95	3.79
Total 2009	**5679.7**	**81881.7**	**1319.39**	**98.2**

Acknowledgements

Coral Engineering Limited would like to acknowledge the valuable assistance of the following personnel in providing the necessary information for this report. Thanks to John Johnston and Larry Braes for their assistance at the various job sites.