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Environment and Sustainability Standing Committee
October 6, 2011

TO: Peter Lund, Chair, Environment and Sustainability Standing Committee

SUBMITTED BY: 
Phillip Townsend, Director, Infrastructure and Asset Management

DATE: September 29, 2011

SUBJECT: Alderney 5 Energy Project

Information Report

ORIGIN

- June 26, 2010, Regional Council In-Camera Report: Alderney 5 Completion
- July 7, 2009, Regional Council In-Camera Report: Alderney 5 Completion
- August 4, 2007, Regional Council Alderney 5 Construction Award Report to HPES
- March 7, 2006, Regional Council Alderney 5 Feasibility Study Award Report to SNC-Lavalin/HPES

BACKGROUND

In August of 2007, Halifax Regional Council awarded a contract to High Performance Energy Systems Inc. (HPES) for the construction of the Alderney 5 Energy Project.

The project consisted of a public-private partnership that included an energy efficiency retrofit of existing municipal buildings on the Dartmouth waterfront and the installation of a unique renewable energy system. The energy efficiency measures included a lighting upgrade, natural gas conversion, and a district energy (heating and cooling) system for the complex of buildings. The new renewable energy system included a seawater cooling system and the world's first Underground Thermal Energy Storage (UTES) system which stores cold energy in a geothermal borehole field for building air conditioning without using heat pump technology. The UTES is designed to harvest cold energy from the ocean during winter months and store it underground for when it is needed six months later during peak summer conditions – acting as a "cold energy battery".

The municipal contribution to the project was $1 million of capital.

In May of 2009, the contract with HPES was terminated for cause. At the time of termination, work on the Project had not been substantially performed. HRM staff discovered serious deficiencies with the work. The termination of the contract meant that HRM and HPES did not enter into a long-term lease agreement. In July of 2009, HRM Council directed staff to complete the project at an additional cost of $589,545. The decision to complete the project was taken despite known deficiencies in the work of HPES and the uncertainty of the performance of the renewable energy system once completed. Some of this additional construction/operation risk was offset by savings that were starting to accrue from already completed phases of the project (the lighting retrofit and natural gas conversion). Subsequent, to HRM Council approval of the $589,454 in additional capital expenditures, more deficiencies related to the seawater intake and piping systems were discovered and rectified within the budget.

In February 2010, the geothermal field and seawater cooling systems construction was completed and connected to the Alderney Gate buildings. A decision to not connect the Ferry Terminal, Old Dartmouth City Hall, and Alderney Landing buildings to the cooling system was taken due to capital constraints, the limited incremental payback and the need to validate the renewable cooling system operation as a priority, prior to further expenditures.

DISCUSSION

Cooling System Operating Results and Textbook Sustainability Principles:

As discussed above, the seawater cooling (and charging) system and the Underground Thermal Energy Storage (UTES) system became fully operational in February 2010. This allowed only one month of cold charging of the system before the seawater temperature became too warm to continue charging. Despite this limited initial charging cycle, and an extremely hot, humid and long 2010 summer season, the new cooling system was able to meet 90% of the cooling needs of Alderney Gate. During the past year, the system went through a full winter charging cycle and

was able to meet **an historic operating point – providing 100% renewable energy to meet all of Alderney Gate's cooling needs in 2011**. This key milestone was also achieved despite a 100% turnover in operations staff. There is excess capacity in the cooling system to incrementally add another 1-2 large buildings to the system.

The Alderney 5 Energy Project encompasses a holistic approach to energy and sustainability. There are strong returns tying together the motivations not only economically but also environmentally. In particular, if the system can continue to provide 100% of the cooling needs from a 100% renewable resource, the CFC based chillers will have become redundant. With over 2,200 lbs. of CFC refrigerants onsite (which are due to be phased out under the Montreal Protocol) and the elimination of high carbon electricity to run the chillers, there are multiple intertwined environmental and economic benefits.

14.9% Return on HRM Taxpayer's Investment:
The initial business case had predicted the project would save $250,000 of the $750,000 in utility operating costs. Currently the project has been experiencing over $400,000 in savings per year – primarily due to electricity costs increasing faster than predicted and the price differential between oil and natural gas having increased the savings.

The initial business case also included savings associated with avoiding future capital to replace individual boilers/oil tanks and individual air conditioning systems (which are all using CFC based refrigerants). It is expected that the current infrastructure installed will avoid over $850,000 in future capital replacement costs.

Using an HRM cost of 4.32% of financing, the current $1.6 million in capital spent on the project, $20,000 in miscellaneous operating costs, annual utility savings of $400,000, and an assumed escalation of energy costs of 3%, the return on the HRM taxpayer investment has been calculated to be 14.9% per year.

Current Legal Issues:
As discussed above, HRM terminated the original contract with HPES for cause in May 2009. As indicated in the July 7, 2009, report to Council, HRM has had three liens placed against it by companies claiming to be sub-contractors of HPES: Northeast Equipment Ltd.; Fred Dunphy Excavating Ltd.; and Palmer Refrigeration Ltd., due to alleged non-payment of invoices. HRM Legal is currently working on this file and has consolidated the liens.

BUDGET IMPLICATIONS

There are no budget implications to this report.

As per the original HRM Council direction Award Report (August 7, 2007), $127,333 of the energy savings from the project in operating account W200-6607 are being used to repay the Capital Replacement Reserve (Q130) withdrawal of $1,000,000, plus 4.32% interest costs, over ten years. This reserve withdrawal was used to fund HRM's original capital commitment to the HPES contract.

As per the July 7, 2009, HRM Council direction on approval of amended construction completion costs, an additional $100,000 of the energy savings from W200-6607 is being put into the Energy and Unground Services Reserve A131, to fund future energy efficiency projects, or as a priority, any financial liabilities resulting from liens against the project.

FINANCIAL MANAGEMENT POLICIES/BUSINESS PLAN

This report complies with the Municipality's Multi-Year Financial Strategy, the approved Operating, Project and Reserve budgets, policies and procedures regarding withdrawals from the utilization of Project and Operating reserves, as well as any relevant legislation.

COMMUNITY ENGAGEMENT

As the world's first geothermal energy storage system of its type, there has been extensive community and industry engagement on this project. An interpretive building (hosting the system's heart) with a public glass looking area and panels explaining the system, is on display on the Dartmouth waterfront encouraging the public to visit.

Geo-Energy Vault for Alderney 5 on the Dartmouth waterfront.

Staff regularly gives tours to the public and industry experts on the system to share lessons learned and experiences of the operating characteristics. Recently, over 150 delegates of the FCM conference had a tour of the system. Natural Resources Canada has written a case study of the Alderney 5 Energy Project and currently QUEST (Quality Urban Energy Systems of Tomorrow) has engaged the Associate Dean of Economics, Dr. Mark Raymond, at Saint Mary's University, to produce a detailed business case study.

ATTACHMENTS

Attachment 1: Copy of the interpretive panel on the Dartmouth waterfront at Alderney 5 Geo-Energy Vault.

A copy of this report can be obtained online at http://www.halifax.ca/council/agendasc/cagenda.html then choose the appropriate meeting date, or by contacting the Office of the Municipal Clerk at 490-4210, or Fax 490-4208.

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Financial Approval by: _____
Mr. Jim Cooke, Director of Finance, CFO 490-6308

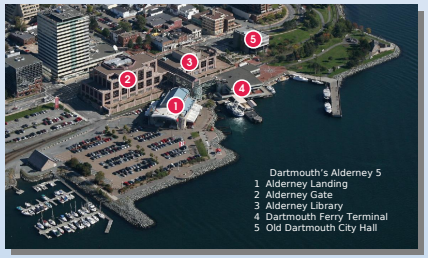
ALDERNEY 5 ENERGY PROJECT – WORLD'S FIRST GEOTHERMAL COLD STORAGE SYSTEM

State of the Art Cooling Technology

The **Geo-Energy Vault** is the heart of a revolutionary geothermal cold storage system. Below you are titanium heat exchangers used to extract cold energy from the Halifax harbour in the wintertime. A geothermal borehole field under the adjacent parking lot stores the cold energy for 7 months. The Alderney 5 seawater cooling and cold storage system provides **100% renewable energy** to air condition buildings on the Dartmouth waterfront.

The Alderney 5 geothermal energy storage system consists of 80 boreholes. Each borehole is 4 ½ inches in diameter and drilled 500 feet deep. The borehole design allows cold energy to be stored in the rock mass, eventually to be used directly for air conditioning **without the need for heat pumps**. By not using heat pumps, the need for refrigerants and electricity to air condition the buildings is eliminated.

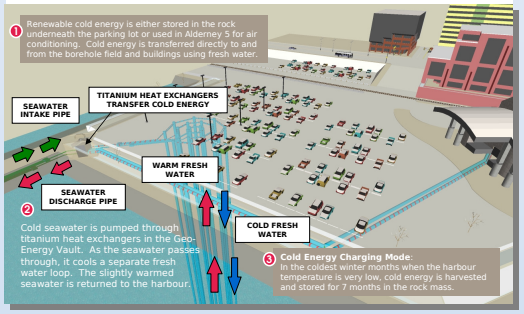
Alderney 5 is the first project in the world to use this technology.



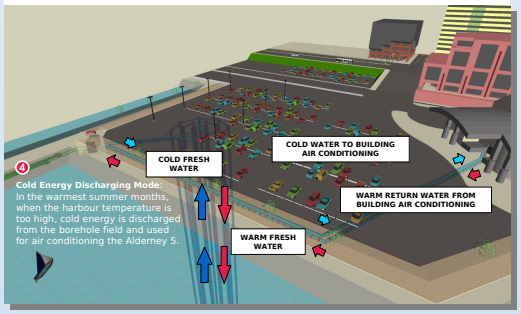
How Does it Work?

The seawater cooling and geothermal energy storage system is a fairly simple concept. In effect, the geothermal energy system acts as a battery, but instead of storing electricity, it holds cold energy. Picture a giant battery the size of a 40 storey building (which is the actual volume of rock used) full of 30 km of piping ready to cool the buildings. A typical borehole in charging and discharging modes is simplified in the diagrams below.

WINTER: COLD ENERGY GEOTHERMAL CHARGING



PEAK SUMMER MONTHS: AIR CONDITIONING MODE



Economic Benefits

The cost of energy is rising, making the $3.6 million Alderney 5 renewable energy project financially attractive. Current annual reductions in energy costs are $350,000. It is also expected to save $800,000 in equipment replacement costs over the life of the project.

This geothermal technology is almost universally applicable. For example, cold energy could be harvested from lakes, ambient air, or other seawater sites. Worldwide demand for cooling and air conditioning is growing rapidly and is becoming a vital necessity. In Canada alone, there is a $50 billion air conditioning replacement market. Rising costs and environmental issues associated with electricity based air conditioning make this innovative geothermal system a sustainable energy alternative.

Environmental Benefits

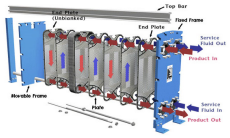
The Alderney 5 seawater cooling and cold energy storage system will have additional environmental benefits beyond energy savings. It should eliminate the need for 2,200 lbs of CFC or other refrigerant based air conditioning in these municipal buildings. The Alderney 5 project has reduced greenhouse gas emissions by 900 tonnes per year since 2009.

Titanium Heat Exchanger

Below you, there are two titanium heat exchangers large enough to air condition all of downtown Dartmouth.

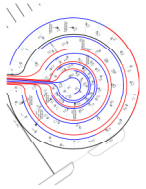
How Does it Work?

A **plate heat exchanger** uses metal plates to transfer heat between two fluids. The concept behind a plate heat exchanger is the use of plates to heat or cool one fluid by transferring heat from another fluid.



As Simple As Penguin Insulating Technology

To survive in the cold Antarctic climate, emperor penguins huddle together. Clustering in groups helps the penguins conserve heat and maintain their body temperature. The outside penguins act as insulation, keeping the inside penguins warm. The boreholes at Alderney 5 work similarly. Like emperor penguins, the outer boreholes insulate the inner ones. However, instead of keeping the centre warm like penguins, the geothermal energy cold storage system is designed to keep the centre boreholes as cold as possible.



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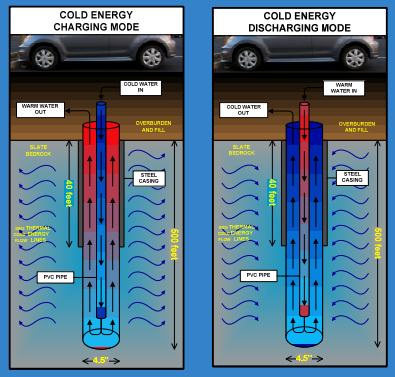


The Creation of a Geothermal Cold Storage System

2007

November 2007

HRM breaks ground on the project in the parking lot of Alderney Landing.

December 2007

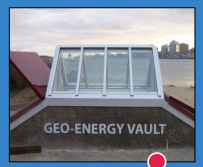
Intake pipes with filters and discharge pipes for the system are installed in the breakwater.

April-May 2008

The Geo-Energy Vault, housing the heat exchangers and pumps, nears completion.

October 2008

The boreholes are connected using almost 30 km of underground piping.



Fall 2009

The Geo-Energy vault nears completion.

2009

November 2007

The two drilling rigs are used for the borehole field construction. One is used to install all the casings to a depth of 40 feet. The second is used to drill to a depth of 500 feet.

January 2008

500 foot boreholes are drilled beneath the parking lot.

October 2008

The parking lot is excavated, exposing the upper 8 feet of the steel casings. The top of the casings are cut and headers are installed.

January 2009

Main supply return lines are connected to boreholes.

Naturally GREEN