INTEGRATED COMMUNITY ENERGY SYSTEM BUSINESS CASE STUDY

ALDERNEY 5 ENERGY PROJECT

JANUARY, 2012

QUEST BUSINESS CASE

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TABLE OF CONTENTS

LIST OF FIGURES

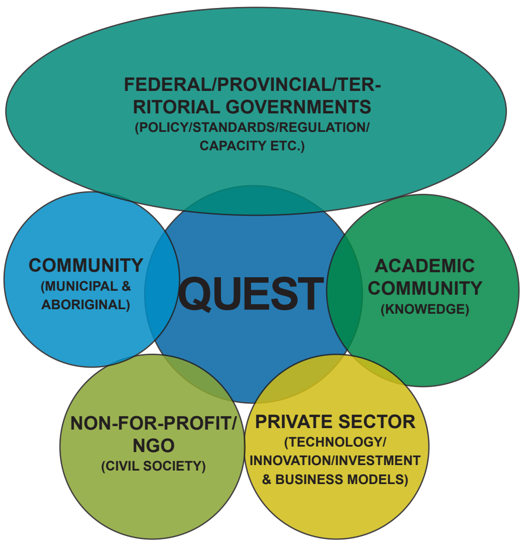
ACRONYMS

CEP	Centralized Energy Plant
EUGS	Energy and Underground Services Committee
HPES	High Perfomance Energy Systems
HRM	Halifax Regional Municipality
IAM	Infrastructure and Asset Management
ICES	Integrated Community Energy System
RPAM	Real Property and Asset Management
TEAM	Technology Early Action Measures
UTES	Underground Thermal Energy Storage

1. PREAMBLE

1.1. QUEST (QUALITY URBAN ENERGY SYSTEMS OF TOMORROW)

QUEST - Quality Urban Energy Systems of Tomorrow – is a national non-profit organization advancing education and research for integrated energy systems (linking energy with land-use, buildings, transportation, waste, water and wastewater at a community, neighbourhood or site level) to develop and support sustainable communities in Canada. QUEST does research, policy analysis, outreach, and capacity building to assist communities, utilities, and the broader community-building sector.



WHO MAKES UP QUEST CANADA?

QUEST Canada is a collaborative network of organizations - from energy, technology and infrastructure industries, gas and electric utilities, all levels of government, civil society groups and community leaders, researchers and the consulting community - actively working to make Canada a world leader in the design, development and application of integrated energy solutions.

QUEST'S MISSION:
Mobilize community builders to create integrated energy solutions that are central to sustainable community development.

QUEST'S VISION:
By 2030 every community in Canada is operating as an integrated energy system, and accordingly, all community development and redevelopment incorporates an integrated energy system.

QUEST is achieving its mission and vision by working with community builders to:

- Encourage a balanced and informative conversation about energy;
- Support the development of expertise and capacity across Canada for integrated energy systems;
- Prepare inclusive and independent applied research for the broader public interest; and,
- Create a collaborative framework for communities and key stakeholders to understand and to work on their energy futures.

1.2. INTEGRATED COMMUNITY ENERGY SYSTEMS

Integrated Community Energy Systems (ICES) capitalize on cross-cutting opportunities and synergies available at the community level by integrating physical components from multiple sectors:

- Land use and community form;
- Energy supply and distribution;
- Water, waste management and other local community services;
- Transportation;
- Housing and buildings;
- Industry.

ICES describe projects that are driven by local issues and community stakeholders and are integrative in nature.

The integration is threefold – first, integration among the various energy sources and technologies, energy users, distributers and producers within a community; second, integration of energy as it relates to other community services, including water, waste, transportation, land use, buildings, and third; integration of energy policy considerations, as these cut across municipal/provincial/federal mandates and priorities.

1.3. BUSINESS CASE STUDY SERIES

While considerable momentum exists in Canadian communities for developing community energy plans and planning for ICES projects, there remains limited Canadian documentation about completed ICES accomplishments. QUEST is working to break-down knowledge barriers and address this important information gap for researchers, developers, investors, and public and private sector decision makers.

QUEST has engaged five of Canada's top business schools to produce QUEST's first Business Case Series featuring ICES initiatives in British Columbia, Alberta, Ontario, Québec and Nova Scotia. The Business Case Series is designed to bring forward the key factors contributing to successful ICES project implementation.

Each ICES business case describes the project, outlining key factors related to governance, financial, technical and economic aspects of project planning and implementation. Taken together, the series provides:

- A vehicle for communicating the ICES concept to the business community and potential supporters of QUEST's work;
- An educational resource advancing knowledge of the financial aspects of ICES project planning and development;
- A foundation for further business-related ICES research; and
- A capacity-development and training tool for developers, municipalities, energy players, other project proponents and the investment community.

2. EXECUTIVE SUMMARY

The Alderney 5 Energy Project was a successful demonstration of an integrated community energy solution (ICES) that used an innovative combination of traditional and new technologies to develop a seawater-based cooling system for a Halifax municipal building complex. The new technology utilizes the cooling effect of the seawater both directly, when seawater temperatures allow, and indirectly through a borehole field that would essentially, store "cold energy".

Water, drawn from the harbour adjacent to the project site, is passed through a heat exchanger before being returned to the harbour. A closed loop freshwater circuit, once cooled in the heat exchanger, is then passed directly to the building's own cooling distribution system. During the winter months, the freshwater is passed through a series of vertical boreholes which serve to sufficiently chill the bedrock of the borehole field for extraction during the warmer summer months. The Alderney 5 Energy Project is able to successfully match the demand for "cold energy" with the supply at a very local level.

The Alderney 5 Energy Project shows incredible promise; while data must still be collected, the summers of 2010 and 2011 were very successful. Of particular importance is the fact that during the winter of 2010/2011 a full "charge" cycle was possible, allowing for the air conditioning needs of the Alderney 5 buildings to be completely met by the new technology during the summer of 2011. A 100% reliance on geothermal technology, without the use of heat pumps, to cool over 30,000 m^2. If these results continue, it will be possible to eliminate the traditional cooling technology (air conditioners and chillers) and the substantial financial and environmental costs associated with them.

While the success of the new technology is very encouraging, stakeholders, namely future municipal and regional governments must be mindful of the risks associated with these sorts of projects. These municipal and regional governments must expect and plan for the inevitable problems and failures that will present themselves with relatively immature technology. It is imperative that safeguards be built into the contracts and financing so that public purses remain insulated from excessive risk.

3. PROJECT OVERVIEW AND TECHNICAL DESCRIPTION

3.1. ALDERNEY 5 ENERGY PROJECT – HISTORICAL BACKGROUND

`The Alderney 5 Energy Project site is comprised of five buildings with a total area of approximately 31,000 m^2: Alderney Gate (top left), Alderney Library (top middle), Old Dartmouth City Hall (top right), Alderney Landing (bottom left) and the Dartmouth Ferry terminal (bottom right).[1]

FIGURE 1: The Alderney 5 Energy Project Buildings and adjacent parking lot[2]

With the ratification of the Montréal Protocol in 1989, the cooling technology and related refrigerants that were in use at the Alderney 5 site (CFC-11 and HCFC-22) would eventually become obsolete.To meet the pending rule changes, organizations were faced with high replacement costs or unproven technologies. Building owners were able to defer their refrigerant management in the short term but significant costs would have to be dealt with prior to the 2010 deadline.[3]

As part of Halifax Regional Municipality's (HRM) Real Property and Asset Management's 2005-2006 Business Plan, an energy efficiency opportunity to reduce the cost of utilities and maintenance in HRM buildings was noted. At that time, HRM buildings produced an estimated 55% of corporate greenhouse gas (GHG) emissions. This was mainly via consumption of energy.   Real Property and Asset Management (RPAM) had identified what it termed as "significant and cost effective opportunities" to become more energy efficient at the Alderney 5 site.[4]

1 Natural Resources Canada (2009) Community Energy Case Study: Dartmouth, NS. Document retrieved from: canmetenergy-canmetenergie.nrcan-
2 Boyle, J. (2011), used with permission.
3 Halifax Regional Municipality (2007) EUGS Report – Alderney 5 Energy Report. Document retrieved at www.halifax.ca/council/agendasc/documents/070807ca1121.pdf
4 Halifax Regional Municipality (2006) RFP 06-020 Alderney 5 Energy Project – Mechanical and Electrical Engineering. Document retrieved at http://www.halifax.ca/council/agendasc/documents/10-1-8RFP06-020.pdf

The timing of three particular events seemed to provide some catalyst to the Alderney 5 Energy Project. Firstly, HRM was approached by Environment Canada to gauge if there was any interest in participating in a pilot project for a new form of geothermal cooling technology. Permission was granted to Environment Canada to drill test bore holes in the parking lot adjacent to Alderney Gate. The proposed pilot project consisted of coupling direct cooling from the harbour with a seasonal Underground Thermal Energy Storage (UTES) system. The UTES system was to consist of approximately 60-120 bore holes, each 11.5cm wide and 150-183 metres deep. In theory, the system would use the colder harbour water during the winter months to remove heat energy from the bedrock. This chilled bedrock could then be used during the warmer summer months to provide for the peak air refrigeration requirements.

Secondly, the recent availability of natural gas at the Alderney 5 facility had prompted HRM to reassess the heating systems and infrastructure of four separate boilers. The third and perhaps most critical element were new funding opportunities and initiatives. Discussions with individuals at Environment Canada and Sustainable Development Technology Canada (SDTC) had identified sources of significant capital that could be explored.

Preliminary estimates of capital requirements for the project were approximately $4.8 million. It was anticipated that federal programs could provide for approximately $3.3 million. In 2006, the Alderney 5 buildings used approximately $630,000 per year in electricity and oil. It was anticipated that these costs could be reduced by more than 50% if both traditional and the new innovative technologies where adopted and successful. Traditional technologies included changes to lighting, boiler upgrades and the elimination of old and inefficient heating systems.[5]

The project was also deemed to be positive in terms of GHG emissions reductions. Initial estimates of 4000 tonnes of GHG emissions represented nearly 4% of the nearly 105,000 tonnes of annual HRM corporate GHG emissions.[6] With closing deadlines for federal funding approaching, HRM decided to stage the engineering work as funding sources were secured through 2006. The original funding sources, both secured and unsecured totalling $472,000 were identified as:

• FCM GMF Application (expected in October 2006)	$223,000
• Sustainable Community Reserve Q127	$150,000
• Environment Canada	$50,000
• Nova Scotia Department of Energy	$25,000
• Natural Resources Canada Energy Innovators Program ERA(P)	$24,000

Total	$472,000

On March 7, 2006 Halifax Regional Council awarded the phase one engineering work for the Alderney 5 Energy Project – Mechanical and Electrical Engineering to SNC-Lavalin (later referred to as HPES – High Performance Energy Systems) for an amount of $10,000 including net HST. Subsequent phases of the engineering work were to be awarded only as cost sharing was secured. The maximum budget was stated to be $472,000 including net HST.[7]

5 Ibid.
6 Ibid.
7 Ibid.

3.2. ALDERNEY 5 – EXISTING CONDITIONS AND ENERGY CONSUMPTION

On May 29, 2007, HPES (High Performance Energy Systems) submitted a draft Energy Feasibility Study to HRM.[8] The study documented the potential energy cost savings that were feasible and examined the energy consumption and cost of the five buildings, considered various retrofits and heating/cooling conversions and estimated costs.

The feasibility study reported that in 2004 actual electrical consumption was approximately 4.5 million kWh and actual furnace oil consumption was 410,900 litres. The report noted that the modeled total energy costs for all five buildings using 2007 energy prices was $787,041 per year.

3.3. TRADITIONAL RETROFIT TECHNOLOGIES

A key risk-mitigating feature of the Alderney 5 Energy Project was to embed three traditional energy retrofit technologies as part of the larger project. First was the installation of new low flow faucet aerators (from 9.5 litres per minute to 1.9 lpm) and as automatic shut-off faucets. The anticipated replacement cost was $13,000. The cost savings were estimated at $8,778 per year. The potential reduction in GHG emissions was estimated at 14.8 tonnes of carbon dioxide.[9]

The second retrofit was the installation of new lighting fixtures. The switch was from standard two-tube T-12 fluorescent fixates with magnetic ballasts to T-8 electronic ballast fixtures. The anticipated replacement cost was $250,000. The cost savings were estimated at $47,071 per year (a blended rate of $0.118 per kWh was used). The reduction in GHG emissions was estimated to be 473 tonnes of carbon dioxide.[10]

The third retrofit involved switching the heating system from fuel oil to natural gas. The existing system utilized oil-fired burners in two boilers. The new system would make use of high efficiency natural gas burners and two condensing boilers. The anticipated replacement cost was $375,000, with estimated cost savings of $128,598 per year. The reduction in GHG emissions was estimated at 219 tonnes of carbon dioxide.[11]

3.4. NEW TECHNOLOGIES - TECHNICAL DESCRIPTION

The riskiest aspect of the Alderney 5 Energy Project lay with the plan to include the geothermal borehole field. The current traditional cooling system for the Alderney 5 buildings was a combination of air conditioning units placed on roof-tops and central chillers. The new system used a seawater-based heat exchange system. The revolutionary advancement was to utilize a "cold energy storage buffer" based on the borehole technology Underground Thermal Energy Storage (UTES) system. The UTES system would end up consisting of 80 boreholes, each 11.5cm wide and approximately 150 meters deep. The anticipated installation cost was $2,908,000, with estimated cost savings of $52,629 per year. The reduction in GHG emissions was estimated to be 413 tonnes of carbon dioxide.[12]

The borehole technology had been developed, patented and was tested by HPES in partnership with Environment Canada. However, the Alderney 5 buildings would be the first commercial scale deployment of this new technology. It was anticipated that the site would also become a successful demonstration of a cooling technology that used 100% renewable technology.

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8 Stewart, D. High Performance Energy Systems Inc. (2007) Energy Feasibility Study for Alderney Five Complex. The study was prepared for Halifax Regional Municipality.
9 Stewart, D. High Performance Energy Systems Inc. (2007) Energy Feasibility Study for Alderney Five Complex. The study was prepared for Halifax Regional Municipality.
10 Ibid.
11 Ibid.
12 Ibid.

HPES was to install a seawater cooling (and geothermal chilling) system that would even be able to provide for the peak air conditioning needs from late July through September. This is the time when the seawater temperatures of the harbour were typically too warm to provide adequate air conditioning.

For direct cooling to occur, water temperatures would need to be below 9°C. As noted in Figure 2 below, estimated Halifax Harbour temperatures exceed this temperature during the warmer summer months. Figure 2 also shows that very cold water is available in the months from January to May. This cold water can be used to chill the bedrock surrounding the borehole field. During the summer, when the harbour water is too warm for direct cooling, the chilled bedrock is able to absorb the heat from the Alderney 5 buildings.[13]

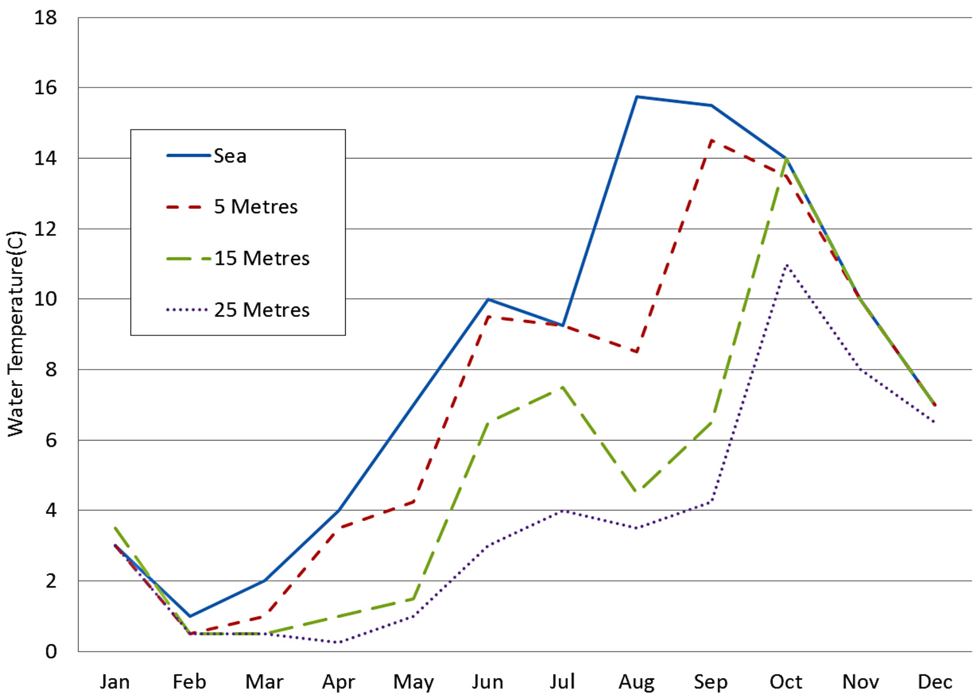

FIGURE 2: Estimated Halifax Harbour Water Temperatures[14]

To give some perspective, this geothermal technique uses a volume of rock the size of a 40 storey building and over 30 km of underground piping.[15] The figures below provide a simplified depiction of the technology.

13 Halifax Regional Municipality (2007) EUGS Report – Alderney 5 Energy Report. Document retrieved at www.halifax.ca/council/agendasc/documents/070807ca1121.pdf

14 Boyle, J. (2007) Alderney 5 Energy Project Brief. Document retrieved from: www.halifax.ca/facilities/documents/AG5EnergyProjectAlderneyEUGSBriefJuly182007.pdf

15 Halifax Regional Municipality (2010) How does it work? Document retrieved at www.halifax.ca/facilities/Alderney5HowDoesitWork.html

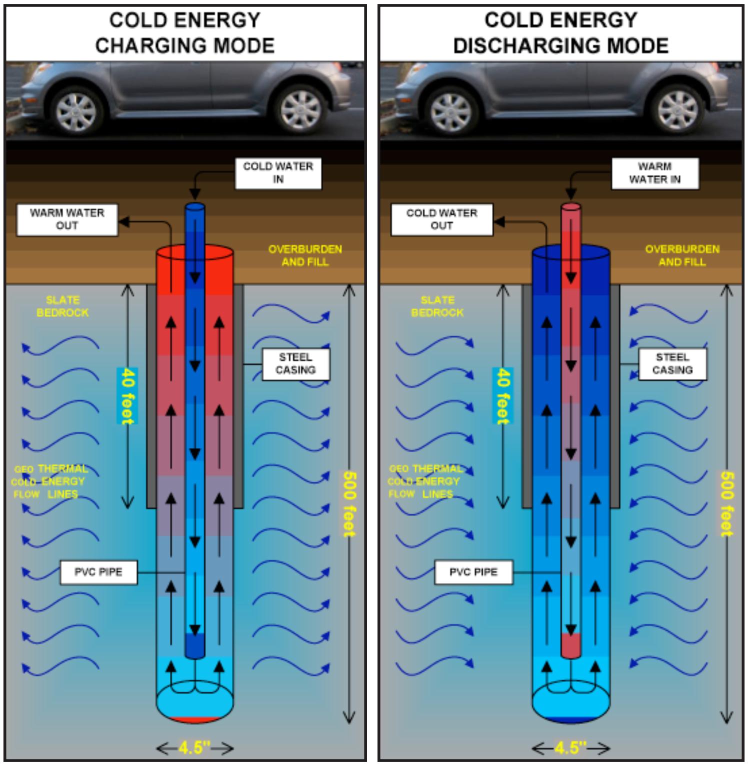

FIGURE 3: Simplified versions of a typical borehole in charging and discharging modes[16]

In the "charging mode" cold seawater is pumped through a heat exchanger which serves to chill a freshwater and glycol mixture that is contained in a closed-loop system. This freshwater is pumped through the underground borehole field which captures the heat energy of the bedrock thus lowering the temperature of the borehole field. The warmed freshwater is returned to the heat exchanger where the heat energy is removed via the cold seawater.

In the "discharging mode" the freshwater in the closed-loop system is pumped through the chilled bedrock where it is cooled. The chilled water is then used to provide for air cooling in the Alderney 5 buildings. The warmed freshwater is then returned to the borehole field where heat energy is removed and the water is again chilled. This process is depicted in Figures 4 and 5 below.

16 Ibid.

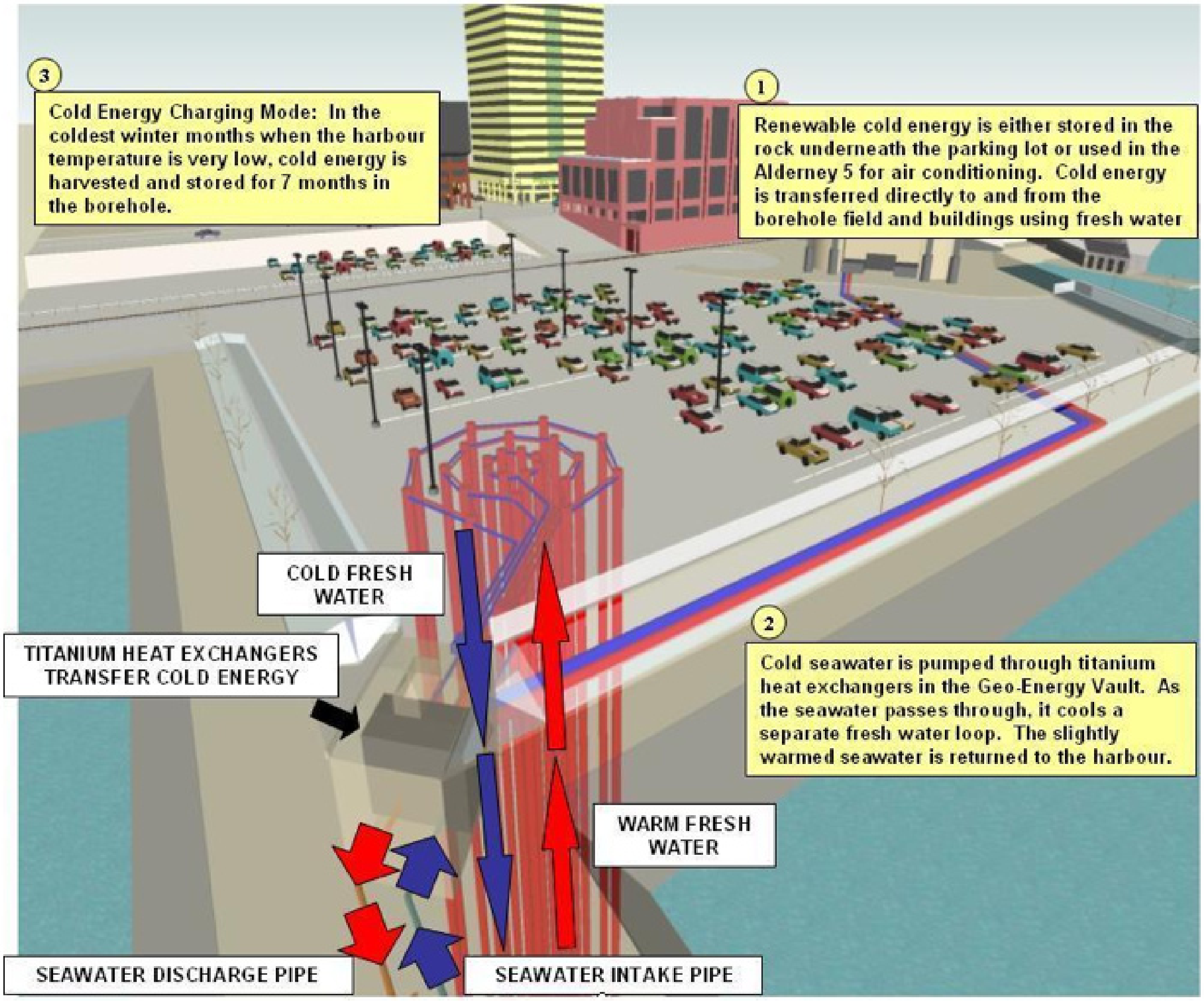

FIGURE 4: Winter months - Geothermal "Charging".[17]

17 Ibid.

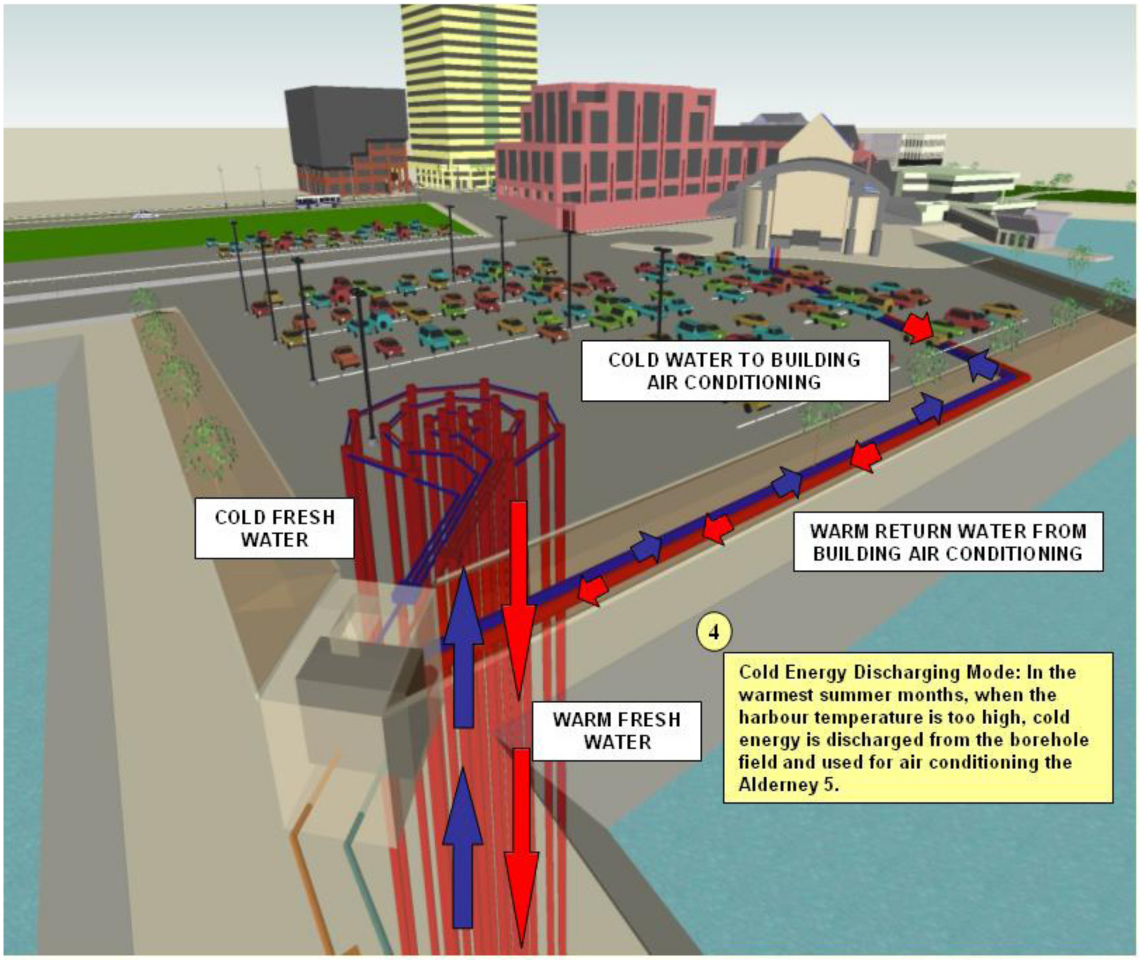

FIGURE 5: Air conditioning mode - summer months[18]

3.5. ENVIRONMENTAL BENEFITS

In a report from the Energy and Underground Services (EUGS) Committee of the HRM Council dated July 18, 2007 it was noted that the environmental benefits alone would be significant with the implementation of this Alderney 5 Energy Project .[19] Five underground oil tanks along with 410,000 litres of furnace oil annually would no longer be used. Approximately 900 kg of CFC based refrigerants would also no longer be used. Further, approximately 900 tonnes of carbon dioxide per year would no longer be released into the environment.[20] This reduction in carbon dioxide emission takes into account the reduced electrical usage and the carbon dioxide emissions associated with its generation.[21] Further, this GHG emission reduction would be audited and the certified credits would be owned by HRM.[22]

18 Ibid.
19 Halifax Regional Council, August 7, 2007. A copy of the report can be obtained online at www.halifax.ca/council/agendasc/cagenda.html
20 This does not account for any other GHG emissions that would also be reduced but have not been estimated.
21 The Alderney 5 complex relies on electricity for the operation of lights, pumps, fans and equipment. In Nova Scotia, electricity is generated primarily by burning coal.
22 In this case study, no estimations are made for a future price of the certified credits. If future positive valuation of such credits does occur, the financial strength of this project is certainly enhanced.

3.6. KEY PROJECT COMPONENTS

The Alderney 5 Energy Project had five essential components. In the July 18, 2007 EUGS report submitted to HRM Council the following project scope and timeline was proposed:[23]

- September 2007 to May 2008 – Mini District Energy System - Heating and cooling pipes redesigned for only one central energy system, located in the Alderney Gate building.
- September 2007 to January 2008 – Gas Conversion and High Efficiency Boilers – Two new high efficiency natural gas boilers located in the Alderney Gate building. Existing boilers will be converted from traditional furnace oil to natural gas.
- September 2007 to June 2008 – Lighting Retrofit – An extensive lighting retrofit will reduce electricity use for lighting by approximately 50%. This lighting retrofit will also reduce cooling load requirements (as lighting fixtures give off significant heat during operation).
- October 2007 to May 2008 - Seawater Cooling – A seawater intake will be installed and run through a titanium heat exchanger. A fresh water system will also run through the heat exchanger. The cooled freshwater will be used for air conditioning. The seawater intake will also be used to "charge" or chill the bedrock via the borehole field during the winter months.
- October 2007 to September 2008 – Geothermal Borehole Field – a borehole field of approximately 80 boreholes, each 11.5 cm wide and 150m deep will be drilled in the rock mass. During the winter months, cold seawater will be used to chill the bedrock of the borehole field. During the warmer summer months, the chilled bedrock (by acting as a large heat sink) can be used to provide for the air conditioning needs of the Alderney 5 buildings.

3.7. ANTICIPATED COST SAVINGS

In 2007 the reduction in annual utility operating costs were estimated to be $250,000.[24] In addition actual "status quo" utility operation costs had risen to $750,000, up from earlier estimates of $650,000. The project also allowed for the avoidance of future capital costs of $330,000 for boiler and oil tank replacement as well as $500,000 in air conditioning equipment replacements.

3.8. ANTICIPATED FUNDING

In 2007 total capital funding for the Alderney 5 Energy Project was estimated at approximately 3.6 million dollars, exclusive of any financing charges. At the time total interest payments were expected to be an additional 1.7 million dollars. Some parts of the financing would be paid back over a ten year period and some parts were over a twenty year period.

The Alderney 5 Energy Project, although bundled as five main sub-projects could also be classified as two project types. The "low risk" or more traditional retrofit projects and the "high risk" or new technology project. At the time the plan was for HRM to provide $1,000,000 in funding and enter into a lease-to-own agreement with HPES for $1,600,000. Federal funding through TEAM (Technology Early Action Measures) would account for the remaining $1,000,000. Lease payments to HPES would begin once the new cooling system was operational. This was anticipated to be in June 2008.[25] The capital lease agreement would serve to transfer some of the operational risk associated with the tested, but as of yet, unproven technology.[26]

23 Halifax Regional Council, August 7, 2007. Document retrieved from: www.halifax.ca/council/agendasc/documents/070807ca1121.pdf

24 Ibid.

25 Ibid.

26 Although the actual funding for the project eventually changed, the interested reader may wish to review the funding details associated with the anticipated funding in the document: Halifax Regional Council, August 7, 2007. A copy of the report can be obtained online at www.halifax.ca/council/agendsc/cagenda.html

4. GOVERNANCE AND INSTITUTIONAL CONTEXT

The Alderney 5 Energy Project conformed well with HRM's overall approach to clean air, land, water and energy and a corporate commitment to "healthy, sustainable, vibrant communities". The project encompassed many of the goals from two existing plans to which HRM had previously committed. First, HRM had previously prepared a corporate plan to reduce GHG emissions from municipal government operations by 20% below 2002 levels by 2012. The plan was adopted by Halifax Regional Council on September 13, 2005.[27]

Second was HRM's 2007 Community Energy Plan (CEP) that was intended to help find cleaner energy sources, including renewable sources, and more efficient ways of using energy in order to meet all of its residents' energy needs.[28]

The Alderney 5 Energy Project's lead department, HRM's Infrastructure and Asset Management (IAM), states that it incorporates financial and environmental life cycle planning into all project decisions. HRM was looking to aggressively reduce both its direct and indirect GHG emissions as part of a voluntary commitment to the Partners for Climate Protection (PCP) program. The Alderney 5 Energy Project did not involve any changes to policy or planning decision making processes as the policies and processes were already in place. A Council sub-committee (the Energy and Underground Services Committee) acted as a steering committee throughout the project's development – from incubation to execution. HRM reports that the scope of the project did not require any changes to the regulatory environment.[29]

4.1. MUNICIPAL GOVERNANCE

HRM reported its top three reasons for undertaking the Alderney 5 Energy complex:[30]

- *HRM Council's commitment to reduce corporate greenhouse gas emissions 20% by 2012. HRM's building operations are responsible for 50% of corporate greenhouse gas emissions and increasing energy efficiency in building operations is the most cost effective method to meet greenhouse gas goals.*
- *The project will save $350,000 in annual utility costs (2008-09), along with $800,000 in avoided capital costs for the replacement of air conditioning systems and heating equipment. Existing CFC-11 & HCFC-22 air conditioning systems won't need replacement to comply with pending and accelerated Montréal Protocol phase out dates.*
- *HRM Council's desire to demonstrate a locally developed, environmentally and economically sustainable energy technology. The Alderney 5 project will demonstrate a world-class cold energy storage system to meet air conditioning needs using 100% renewable energy.*

The fundamentals for this project seemed reasonable. The low-risk technological retrofits would work well, but the possibility of eliminating redundant and expensive air conditioning systems would ultimately be the key in meeting these three objectives.

4.2. AN UNEXPECTED OWNERSHIP AND OPERATING MODEL

In May of 2009, HRM cancelled its contract with HPES and in July 2009 HRM council agreed to spend approximately $600,000 to complete the Alderney 5 Energy Project.[31] As well, HRM would completely take over control of the project, assuming the role of general contractor. At the time the project was to have been operational for almost one year.

27 Interested readers may wish to read more at www.halifax.ca/council/agendasc/documents/CorporateGreenhouseGasEmmisions.pdf and www.halifax.ca/environment/documents/HRMCorporateClimateLocalActionPlan.pdf

28 Interested readers may wish to read more at: www.halifax.ca/environment/energyplan/index.html

29 www.halifax.ca/facilities/Alderney5EnergyProjectPolicyandGovernance.html.

30 www.halifax.ca/facilities/Alderney5.html

31 A copy of the newspaper article from the Halifax Chronicle was retrieved from: www.halifax.ca/facilities/documents/Alderney5CH070110.pdf

An examination of HRM council meeting minutes on July 7, 2009 and June 22, 2010 confirms issues with the firm originally assigned the task of completing the Alderney 5 Energy Project. Although details remain confidential, HRM would now be assuming the risk associated with finishing the project.[32] On January 6, 2010 HRM released the following press release:

(Wednesday, January 6, 2010) - The Halifax Regional Municipality (HRM) has started operating the geothermal cold energy storage system as part of the Alderney 5 Energy Project. The project uses natural gas, efficiency strategies and leading edge geothermal technology. It will reduce greenhouse gas emissions by over 900 tonnes per year.

Currently the cold energy storage system is charging. In the spring, it will be used to provide air conditioning to municipal buildings on the Dartmouth waterfront.

"Alderney 5, the only system of its kind in the world, has the potential to produce significant operating and capital cost savings," said Mayor Peter Kelly. "Already the project has resulted in savings of $350,000 in energy costs and is contributing to Council's commitment to meet a 20 per cent greenhouse gas reduction target by 2012."

HRM now has more geothermal systems than anywhere else in Atlantic Canada. The lessons learned with this project have been a catalyst to understand and operate other geothermal systems. Community centres in East Dartmouth, Fall River and Prospect also use geothermal technology.

"In Alderney 5's case, with the pending phase-out of CFC-based air conditioning and increasing demand for air conditioning, this technology is a prime example of how sustainable, integrated energy solutions can be used to reduce carbon cost effectively," said Julian Boyle, project manager.

The underground thermal energy storage (UTES) system was constructed by drilling 80 holes, each 500 feet deep and coupling it with a seawater cooling system. Cold energy will be harvested during the winter months and stored underground in the rock mass via borehole heat exchangers.[33]

32 Halifax Regional Council, July 9, 2009. Documents retrieved from: www.halifax.ca/council/documents/c090707.pdf and www.halifax.ca/council/agendasc/documents/INCAMERARECOMMENDATIONS.pdf

33 A copy of the press release was retrieved from: www.halifax.ca/mediaroom/pressrelease/pr2010/100106Alderney5Geothermalcommences.html

5. FINANCING AND ECONOMICS

5.1. ORIGINAL TOTAL PROJECT CAPITAL FUNDING

The original calculations for the project as noted in the Halifax Regional Council meeting minutes on August 7, 2007 were as follows:

Halifax Regional Municipality

$1,000,000 contribution from HRM
$1,689,143 HRM-HPES Capital Lease (of which $89,143 is HST)

High Performance Energy Systems

$1,000,000 TEAMS Canada, HPES-TEAM Agreement

The lease payments to HPES were scheduled to begin when HPES could provide the renewable air conditioning services to the Alderney 5 building complex, anticipated to start in June of 2008, with the "cold energy" supplied by HPES to be metered. The lease payments were to be based on the quantity of the "cold energy" delivered, with a variable payments set out in contract based on air conditioning needs. A 20 year lease was anticipated.

5.2. NEW TOTAL PROJECT FUNDING

In July 2009, HRM found itself the owner of a project that was not operational and ultimately unproven. With the Alderney 5 Energy Project finally becoming operational on January 6, 2010, the new funding analysis would be now considered a work in progress. HRM made conservative estimates for the Project's recurring operating costs and the avoided capital costs[34] in the first twelve months. The "status quo" had recurring operating costs of $750,000 per year. The estimates for the costs and savings associated with the Alderney 5 Energy Project are presented below:

Alderney 5 Project Costs/Savings	
Total Capital Cost	$2,800,000
Cost Sharing – Federal funds	($1,000,000)
Avoided Capital	($200,000)
Financing Costs	$112,000
Net Capital Cost	**$1,662,000**
Operating Savings	
Operating Savings-specific	$0
Operating Savings-recurring	($350,000)
Greenhouse Gas Revenues	$0
Subtotal Operating Savings	**($350,000)**
Net Project Costs (Savings)	**$1,362,000**
Present Value Costs (Savings)	$1,362,000
Cumulative Costs (Savings)	$1,362,000

34 The avoided capital costs are based on boiler/oil tank replacements. The larger avoided capital costs associated with new air conditioning units are not included in the initial twelve month calculation.

HRM also made calculations with respect to return on investment and the payback period. Again, conservative estimates were made with respect to the general inflation rate, the specific inflation rate (project specific), finance and discount rates, as well as avoided capital expenditures. As a result, the initial estimation for the payback period was 6 years, with an average annual return on investment of 14.2% and saving over $5,100,000 (net present value) over a twenty year period.

The system began initial operations on January 6, 2010. A full winter season with the cold seawater temperatures was not possible due to the timing of the start-up, however, during the summer of 2010 the geothermal technology showed great promise. Conservative estimates indicated that the new technology was working and providing approximately 85% to 90% of peak air conditioning requirements. Of particular interest was the fact that the new technology did not have a full winter season to "charge" the borehole field and the summer of 2010 was one of the warmest on record.

During the winter of 2010/2011 a full "charge" cycle was possible. With the borehole field fully charged, the air conditioning needs of the Alderney 5 buildings were being completely met by the new technology during the summer of 2011. **A 100% reliance on geothermal technology, without the use of heat pumps, to cool over 30,000 m².**

Since original financial estimates were made in the fall of 2009, new information on costs and savings allowed HRM to conservatively re-estimate the Project's first year financial numbers as well as future costs and savings. Specifically:

Alderney 5 Project Costs/Savings	
Capital Cost	$2,800,000
Cost Sharing	($1,000,000)
Avoided Capital	($250,000)
Financing Costs	$112,000
Net Capital Cost	**$1,662,000**
Operating Savings	
Operating Savings-specific	$0
Operating Savings-recurring	($400,000)
Greenhouse Gas Revenues	$0
Subtotal Operating Savings	**($400,000)**
Net Project Costs (Savings)	**$1,262,000**
Present Value Costs (Savings)	$1,262,000
Cumulative Costs (Savings)	$1,262,000

Again using conservative approximations, the updated estimation for the payback period was now 5 years with a return on investment calculated to be 19.29%. Over the twenty year period the Alderney 5 Energy Project, in net present value, would now save over $6,900,000.

The above calculations over the twenty year period do allow for an avoidance of capital costs in future years. If the new technology remains reliable, new air conditioning systems will not be needed. This will result in avoided capital costs of approximately $500,000. Some models allow for the avoided capital in Year 5 and some allow for the savings in Year 9. The return on investment is not overly sensitive to the timing of the future capital avoidance. This is due to the fact that the payback period for the Project is 5 years and therefore before any decision on what should be done with outdated air conditioning technology.

6. ANALYSIS AND DISCUSSION

6.1. STAKEHOLDER ENGAGEMENT

HRM maintained and continues to maintain a dedicated website[35] which deals with the Alderney 5 Energy Project as well as many of the other the large capital projects that it is involved in. The use of a web site allows for the quick dissemination of relevant information to interested parties for a relatively low cost.[36] The web site has notes explaining the project and various media coverage. The Alderney 5 Energy Project did complete an Environmental Assessment and during the early stages of the project discussions took place during the HRM Council meetings. This allowed for consultation on a broader level and input from a wider constituency.

Of particular importance was the establishment of the "Geo-Vault". Located adjacent to the parking lot under which the borehole field has been drilled, the Geo-Vault is a small building that houses the various pumps, filters and valves for the borehole field. The small shed like building has windows and signage that allow visitors, invited guests and passers-by to familiarise themselves with the project's unique technology. The presence of the Geo-Vault is an essential part of HRM's efforts to educate the public and advertise the Alderney 5 Energy Project's substantial accomplishments.

6.2. ENVIRONMENTAL ASSESSMENT

The Alderney 5 Energy Project is registered with the Canadian Environmental Assessment Registry. The registry number is 07-01-29633 and is available online.[37]

On June 5, 2007, under section 5 of the Canadian Environmental Assessment Act, it was determined that an environmental assessment was required. The project was being assessed as required by subsection 5.1 (c) under the Canadian Environmental Assessment Act. Of particular importance was Natural Resources Canada's involvement via TEAM financing.

On September 19, 2007, after taking into consideration the screening report and the implementation of appropriate mitigation measures, it was decided that the project was not likely to cause significant adverse environmental effects.[38]

6.3. DESIGN AND CONSTRUCTION EXPERTISE

Prior to the Alderney 5 Energy Project, three major seawater cooling systems had already been completed in the HRM – Halifax Harbour vicinity. Purdy's Wharf, the Halifax Casino and the Bedford Institute of Oceanography all had seawater based cooling systems. Thus, the introduction of intake and outflow systems, along with the associated filters was not brand new to the community.

For the traditional retrofitting aspects of the Alderney 5 Energy Project such as low flow faucets, energy efficient lighting and boiler changeover, the local expertise via contracting was and is extensive. The same can be said for borehole drilling. Given that this new design technology had never been completed on a large commercial scale, "problem solving" expertise was important, as no firms would have had much, if any, experience with the new technologies.[39]

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35 http://www.halifax.ca/facilities/Alderney5.html
36 http://www.halifax.ca/facilities/Alderney5HowDoesitWork.html
37 http://www.ceaa.gc.ca/052/details-eng.cfm?pid=29633
38 Ibid.
39 With the benefit of hindsight, HRM might have been advised to utilize a design-bid-build project implementation schedule verses the design-build schedule that was adopted. See Halifax Regional Municipality (2007) EUGS Report – Alderney 5 Energy Report. Document retrieved at www.halifax.ca/council/agendasc/documents/070807ca1121.pdf

The project team also collaborated with the International Energy Agency.[40] Thus the Alderney 5 project was a culmination of research and development between local engineers, Environment Canada and international experts.

6.4. EASE OF REPLICATION

Although there are a few relatively unique characteristics or municipal features that were a critical part of the Alderney 5 Energy Project's success, replication is possible in several urban locations in Canada and internationally. Clearly, Alderney 5's proximity to the Halifax harbour is instrumental to this project. However, other sources, such as lakes, rivers, or cooling towers could also be considered for a project like this.

Cities with large space cooling requirements, high electricity costs and cold winters are ideally suited. Along with "harvesting" cold energy in the winter, the borehole design could also be coupled with more traditional geothermal heat pump designs, increasing the effectiveness of geothermal heating applications too.[41]

The current success of the Alderney 5 project has led to numerous local, domestic and international inquiries. Of particular interest is the potential for the current borehole field to provide for additional space cooling to nearby buildings. If the current success of the project continues, not only can redundant air conditioners be dismantled and eliminated, but excess cooling capacity can be delivered to adjacent neighbouring buildings contributing to further financial gains and GHG emissions reductions.

6.5. RISK MANAGEMENT

The original plan, that involved a capital lease buy back between HRM and HPES allowed HRM to mitigate its exposure to the technological, and ultimately financial, risks associated with the new borehole field technology. Although field tests showed promise, it was not certain that the technology would work on such a large scale and more importantly, if it would allow for 100% reliance on geothermal air conditioning without the use of heat pumps. If 100% reliance was not possible, it would be necessary for the Alderney 5 buildings to own, maintain and occasionally operate a secondary and redundant air conditioning system to meet peak cooling needs.

From HRM's perspective this project involved significant risk. This became critical when the contract with HPES was terminated. It is important to recognize that projects which propose new technologies involve significant risk. Any municipality or government agency should employ "in house" technical and financial staff to help in mitigating risks associated with such advanced technologies. Of particular importance would be a contract format that allows for several "check in" dates and performance reviews. Partnering and conversing with both Provincial and Federal departments with access to and knowledge of broader technical resources would also be prudent.[42]

40 Annexes 14 and 20 would be most relevant for the Alderney 5 Energy Project. See www.iea-eces.org/annexes/ongoing-annexes.html andwww.ecbcs.org/annexes/annex14.htm
See www.halifax.ca/facilities/Alderney5Leadership.html
41 See www.halifax.ca/facilities/Alderney5Leadership.html
42 www.halifax.ca/facilities/Alderney5Leadership.html

It is recalled that in early 2009 CanmetENERGY of Natural Resources Canada wrote[43] of the Alderney 5 Energy Project:

- *The public-private partnership project used an innovative contract structure that combined a turn-key capital construction project and capital lease agreement that shared the construction and operating risks with the private partner. The contract structure is what enabled the municipality to participate in the project without excessive risk.*
- *No specific tools were developed to help partners work more effectively, other than an ftp site to share files. Very regular and intensive project meetings were held to communicate key information and joint understanding of issues. There were many unexpected changes in the course of developing the final project scope and financing. Basic communication skills were crucial in resolving issues (i.e. meeting agendas, minutes, regular email/telephone communications, open dialogue/information sharing, trust).*

43 canmetenergy-canmetenergie.nrcan-rncan.gc.ca/fichier/81088/DE%2010%20Alderney%20Five%20Geothermal%20Project%20(ENG).pdf

7. CONCLUSION

The Alderney 5 Energy Project encapsulated both traditional and new technologies. A key objective was to further develop a seawater based cooling system for the municipal building complex. The new technology would utilize the cooling effect of the seawater both directly, when seawater temperatures permitted, and indirectly through a borehole field that would essentially, store "cold energy".

Water, drawn from the harbour adjacent to the project site, would be passed through a heat exchanger before being returned to the harbour. A closed loop fresh water circuit, once cooled in the heat exchanger, is then passed directly to the building's own cooling distribution system or, during the winter months, passed through a series of vertical boreholes which serve to sufficiently chill the bedrock of the borehole field.

The Alderney 5 Energy Project ultimately shows incredible promise. While data must still be collected, the summer of 2010 and 2011 were very successful. Of particular importance is the fact that during the winter of 2010/2011 a full "charge" cycle was possible. As such, the air conditioning needs of the Alderney 5 buildings was completely met by the new technology during the summer of 2011. **A 100% reliance on geothermal technology, without the use of heat pumps, to cool over 30,000 m^2.**

While the success of the new technology is very encouraging, future municipal and regional governments must be mindful of and mitigate the risks associated with these sorts of projects. These municipal and regional governments must expect and plan for the inevitable problems and failures that will present themselves with relatively immature technology. It is imperative that safeguards be built into the contracts and financing so that public purses remain insulated from excessive risk.