NOVA SCOTIA Energy

ecoNova Scotia for Clean Air and Climate Change

NOVA SCOTIA Environment

Environmental Technology Program- Application Form

Updated October 2008

The Environmental Technology Program (ETP) will support the development, demonstration, adoption and commercialization of environmental technologies and innovations that reduce greenhouse gas (GHG) and air pollutant emissions while advancing sustainable prosperity in Nova Scotia. For complete details of the program, review the Environmental Technology Program Guideline at http://www.gov.ns.ca/ecoNovaScotia/forms/.

BEFORE YOU START, PLEASE REMEMBER:

- Review the Environmental Technology Program Overview and Application Form Guideline before completing this application form.
- Complete and submit your application electronically using this form- *this is mandatory*.
- Mandatory attachments are identified at the end of this form. If they cannot be included at the time of submission, indicate the reason and when they will be forwarded.
- Other information that is relevant to the project application can be attached. Clearly identify any attached documents in the space provided at the end of this form.
- Incomplete application forms will automatically be considered ineligible. Applicants are advised to submit applications early and request that the Fund Coordinator review the document(s) to ensure it is complete.
- The Fund Coordinator reserves the right to contact the proponent at any time during the evaluation process for clarification or to obtain additional information.

1. Project Title

Provide the title for the proposed project.

MinThermal – Mine Water Geothermal Applications in the Sydney Coal Field

2. Applicant Information

Identify the lead applicant for the Environmental Technology Program.

Lead Applicant Organization:	New Aberdeen Garden Townhouses Inc		
Contact Person & Title:	Luciano Lisi, VP Business Development		
Address: *Please provide mailing and civic address.*	11 Eleventh Street Glace Bay, NS B1A 4M3	Phone:	902-849 4688
		Fax:	902-539 4143
		Email:	luciano@cbexplorations.com
Alternate Contact: *Please provide contact information for an alternate contact.*	Christine Kavanagh, President 902-537 0451 christinekavanagh@capebretonhydro.com		

Provide the contact information for any partnering organization. A partnering organization is defined as any organization that has confirmed contribution to the project either financially or in-kind. *Copy the chart below if there is more than one partnering organizations.*

Partnering Organization:	Cape Breton University – Chair for Mine Water Remediation & Management		
Contact Person & Title:	Prof. Dr. Christian Wolkersdorfer		
Address:	PO Box 5300 Sydney, Nova Scotia, B1P 6L2	Phone:	+1 902 563 1285
		Fax:	+1 902 563 1285
		Email:	c.wolke@cbu.ca

3. **Project Description (Executive Summary)**
Provide a brief (*200 words or less*) description of the project. It should be clear and concise, and provide an easily understandable overview of what you are proposing.

MinThermal's project goal is to install, monitor and research a wind powered geothermal heat system for a senior citizens home in Glace Bay (Cape Breton). Glace Bay is located above the flooded mine workings of the abandoned Dominion № 2 and № 9 coal mines with mean temperatures of 13–16 °C, 7.6 Million cubic meters of water and depths of several hundred meters. Based on regular hydrogeological and hydrodynamic investigations and on-site monitoring, the most appropriate available geothermal technology, will be chosen. Furthermore, the optimal location of the production and injection bore holes will be a result of those investigations. Similar projects worldwide revealed that mine water chemistry and the flow of the water can negatively interfere with the geothermal system. MinThermal therefore aims in the research of innovative technology to overcome the current shortfalls of those geothermal applications by modifying the geothermal probes or the injection and production parameters of the wells. Moreover it shall ensure a positive legacy of the abandoned mine workings. From comparable projects in Europe it is known that a 45 % reduction of greenhouse gas emissions will be anticipated for the geothermal part and nearly 100 % in combination with the wind turbine.

4. **Project Objectives: 10 Points**
Prepare a description of the goals/objectives of the project. Indicate how it will support the development and/or commercialization of environmental technologies/innovations with the goal of reducing greenhouse gas and air pollutant emissions, as well as advance sustainable prosperity in Nova Scotia. Include:

- Short and long-term objectives of the project, and
- The specific deliverables of the project.

Key goal of MinThermal is the commercialization of mine water based geothermal energy systems (also called earth energy systems) and the technologies needed to investigate mine pools with geothermal potential. This goal will be reached by studying, modifying, and monitoring a pilot and demonstration project in Cape Breton's Glace Bay, where mine water geothermal energy shall be used to heat a senior citizens home. By using the sustainable energy resources, geothermal energy as the heat resource and wind energy to drive the heat pumps the project will avoid fossil fuels to heat the building. Therefore, under standard working conditions, no greenhouse gas emissions will be released by the system. Furthermore, the project will make use of a waste product (mine water), which otherwise would be discharged into the anthroposphere without further benefit for the Nova Scotian population. As the location of the project was selected to expand the project to a district heating system, a positive project result will be used to install a district heating system in Glace Bay, thus further reducing the greenhouse emissions for heating purposes.

As can be seen from the following list of work packages, the complete project will exist of research into the geothermal source (highlighted in italics) and its commercialization:

1. Research the Geothermal Resource

2. Research the available Technology

3. Investigate the necessary Capital Costs

4. Calculate the expected Operational Costs

5. Examine the Environmental Challenges

6. Investigate the potential for a geothermal district heating

7. Monitor and optimize the Utilization of the mine water geothermal energy

Deliverables of MinThermal are:

- tools to investigate the physico-chemical behaviour of mine water in geothermal systems
- optimized selection methods for heat exchanger or heat pump technology for mine water
- innovative mine water tracer tests to study the flow of water in the mine pool
- public information
- onsite training of interested parties

5. **<u>Organization Background and Experience</u>: 8 Points**
Provide background information about the organization(s) involved.

5.1 Describe your organization and its structure, length of existence and number of members, including the full legal corporate/organization name. Include information on partnering organizations as well.
CBU – Cape Breton University, since 1951, ca. 3500 students, for other information see website www.cbu.ca Cape Breton Explorations Ltd formed in 2004 to develop Renewable Energy Projects in Nova Scotia. Built the second largest wind farm in Nova Scotia: The Glace Bay Lingan 17.5 MW wind farm. See Attachment (3) in Attachment List.
5.2 Identify your organization's mandate and main objectives. Detail how this relates to the project as proposed. Include information on partnering organizations as well.
Education and Research; partnering in the project will be the Industrial Research Chair for Mine Water Remediation & Management; CBU has a long lasting history in partnering with the private sector. This can be seen by the fact that the Research Chair is co-financed by a non-university institution (Cape Breton Development Corporation). The Research Chair itself has a long project experience from Germany (see website www.wolkersdorfer.info)
5.3 Highlight the experience of the project personnel and partnering organizations that is relevant to the proposed project. • Prof. Dr. Christian Wolkersdorfer (minewater.cbu.ca) will be the lead researcher in the project, assisted by a to be named researcher and technician. He is a member of the German Geothermal Association and was a member of the German Geothermal Governmental Advisory Board. He conducted several geothermal projects in Germany (Enhanced Geothermal Systems, Hydrogeothermal Systems) and has a 19 year expertise in mine water related studies. • NN (full time): Researcher with experience in modelling geothermal resources as well as monitoring and sampling mine water. He or she shall also be experienced in the interpretation and modelling of hydrogeological data. Furthermore he or she shall have experience in near surface geothermal applications. • NN (part time): Technician with experience in maintaining monitoring equipment and laboratory equipment as well as experience in using databases to host the geothermal and mine water data collected. Furthermore experience in maintaining web pages to update the project's web page (http://MinThermal.wolkersdorfer.info) and experience in media relation to promote the project. • Luciano Lisi - President and Chief Financial Officer, Director. Moved to Canada in 1978 from Italy. President, CFO. Areas of expertise include private and public financing, prospectuses, IPO's, venture capital, Canadian and international banking. Luciano was founder/developer of Cape Breton Power Ltd. and Glace Bay Lingan Wind Power Ltd. currently the second largest wind farm in Nova Scotia with approximately 17.3 MW of installed capacity. • Christine Kavanagh - Vice President, Director. President and CEO of several private companies for the last 25 years, Christine has produced Television programs and feature films for the international market. Returned to Cape Breton in 2001. President of several companies encompassing international film production and distribution, mining and exploration. Areas of expertise include contractual negotiations, human resources and corporate management. • Christine was also founder/developer of Cape Breton Power Ltd., and Glace Bay Lingan Wind Power Ltd. • R.L. (Bob) Johnson P.Eng – Senior Supervising Electrical Engineer. Bob joined CBEX in September 2007 after a 33-year progressive career with Nova Scotia Power. During his career he designed and project managed the construction of several distribution and transmission substations. He was manager of the substation and transmission line group, plant manager of the Tufts Cove Generating Station (1993-1999), manager of the Quality Management & Customer Needs group (1999-2001), and managed the Renewable Energy Development group (2001-2007). Under Bob's leadership, Nova Scotia Power's Renewable Energy group initiated wind energy development in the province and awarded 60MW of wind power contracts to several developers. Bob has very good relationships with Nova Scotia Power and a solid understanding of the utility's infrastructure. • Colin Reynolds, P.Eng, Development, Director. Colin is a Geotechnical engineer. • John Nash, CA, - Director; Chartered Accountant, Senior Partner of John Nash & Associates accounting firm in Sydney, Nova Scotia • Dwight Rudderham, Chairman. Barrister, Senior Partner with Rudderham & Chernin Barristers and Solicitors, Sydney, Nova Scotia • Marty Chernin, Director. Local Cape Breton real estate entrepreneur and businessman

6. **Project Background: 8 Points**
Use this section to provide the background information on the proposed project, demonstrating how it capitalizes on an opportunity.

Indicate project focus:
- ☑ Technology Development and Commercialization
- ☑ Technology Adoption and Deployment, Pilot and Demonstration Projects

6.1 Project description
- Describe the "resulting product(s)" that would be developed during this project. "Resulting product" is broadly defined as a new technology-based product, process or service developed as part of the project.
- Explain how this project fits within the objectives of the ETP.

One of the largest mine pools in Nova Scotia is located in northern Cape Breton. 250 years of coal mining left a legacy of about 100 partly flooded coal mines. Their mine water pool comprises some 190 Million m³ with the 1B mine pool and 7.6 Million m³ being the largest single mine pool on Cape Breton Island. In 1997 several depth dependent temperature measurements were conducted within the 1B shaft in Glace Bay, revealing a mean mine water temperature of 13.1 °C (Lapierre 1999) and maximum temperature of 16 °C in borehole PBH-01-1 in 2008 (CBDC pers. comm.). The MinThermal project will therefore focus on research and process optimization at a pilot project in Glace Bay, where private funding and community involvement will build a green energy senior citizens home. Selection of this location is based on the potential availability of geothermal energy (Arkay 2000) as well as wind energy and a possible extension to a district heating system. Interestingly, the first investigations in using abandoned mines as a resource for energy were conducted in 1978, but the results of this study never led into the construction of a geothermal mine water plant (Lawson & Sonderegger 1978). Other than at the Springhill area, the mine water in the Sydney Coal Field is generally of lower temperature as a result of the lower depths of the mine workings and an interaction with shallow ground water. Therefore the requirements for the heat exchangers or the heat pumps – whichever technology shall be used – are more stringent than those at the Springhill site. Furthermore, this Geothermal Project shall heat a large senior citizens home with a heat demand of more than 700 kW per year. This fact makes it necessary that the whole system must be reliable and efficient enough to extract the heat from the relatively low temperatures of the mine water in the Sydney Coal Field. Another issue, which stands out from the Springhill project, is the re-injection of heat from a non-heat-producing residential building. All the heat which is generated in the residential building and from industrial complexes of the Sydney Municipality area (e.g. the Lingan Power Plant) shall be re-injected in the mine pool in that way that the mine pool reacts as an aquifer heat storage.

Another major difference is the extent of the mine water pool. Whereas the Springhill mine water pool hosts about $4 \cdot 10^6$ m³ of mine water the mine pool of the Sydney Coal Field is more than a magnitude larger. This implies that possibly several hundreds of homes could be connected to the geothermal source. Therefore the investigation of potential flow paths of the cool mine water is very important as a proper understanding of the flow paths insures that no shortcuts build up in the system.

The innovative part of the project described here, compared to the already existing systems in Springhill or elsewhere, will be six fold:

- Extract heat from a mine water with a mean temperature of around 10–14 °C
- Heat a large building complex
- Extract mine water from greater depths
- Investigate the potential for re-injecting heat into the mine water pool during summer time
- optimization of heat extraction mechanism (heat exchanger *vs*. geothermal probes *vs*. heat pumps)
- investigation of interaction between mine water chemistry and heat exchangers

The full, partly privately financed project will encompass a wind turbine to power the geothermal heat exchangers and comprises six work packages. Since the project is a co-operation between a small business located in the Cape Breton Municipality, Cape Breton Development Corporation, and Cape Breton University, parts of the work packages will be based on existing technology while others need intensive research to make use of the geothermal resources on Cape Breton Island. Compared to the several 100,000 standard geothermal installations word wide (according to GLOBE-Net 2008 the estimate for Canada is 30,000 installed systems), just about 20 mine water based systems are in operation. This number indicates that there are several problems related to using mine water as a geothermal source which mainly relates to the aggressive quality of the mine water and the hydrodynamic processes governing the flow of the water in an underground mine. MinThermal will fill this lack of mine water applications by research on approved heat exchangers and heat pumps for mine water as well as studying the optimal locations for production and injection wells of such systems.

6.2 Background information

- Indicate the justification and/or scientific basis for the proposed project (e.g., proof of concept and demonstration of need). Remember to identify references to key scientific and technical literature, and provide the rationale and key assumptions that support this project.

According to the Nova Scotian Environmental Goals and Sustainable Prosperity Act, the Province aims to reduce the greenhouse gas emissions to 10 % below 1990 levels and plans to increase the amount of renewable energy by at least 20 % until the year 2013. To do so, it is necessary to improve existing renewable energy systems on one side, but to invest and research into new resources of such type of energy on the other hand. One of those resources in Nova Scotia that, over and above, has an increasing potential, is the use of geothermal energy. Simplified, three depth depending types of geothermal energy systems can be distinguished: near surface geothermal systems (usually up to 400 m depth, low enthalpy systems), hydro-geothermal systems (below 400 m, down to approximately 5000 m) and enhanced geothermal systems (4000 – 6000 m below the surface, high enthalpy systems). Based on that fact, one type of geothermal energy can always made available at nearly every location on our earth, and also in Nova Scotia. The same conclusion has been drawn by Raymond & Therrien (2008), who state that “geothermal energy extraction can be undertaken at most of the flooded Canadian mines where there is need for heating”.

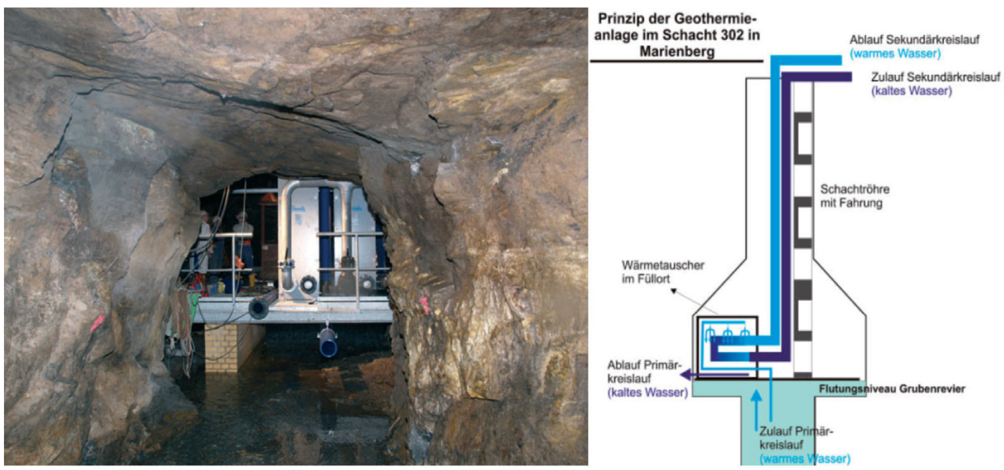

Fig. 1: Example of a Mine Water Geothermal Plant in the Ehrenfriedersdorf/Germany underground mine (modified from Matthes & Schreyer 2007).

Currently, Nova Scotia produces about 3 % of its energy from near surface geothermal systems including geothermal probes, geothermal groundwater heat pumps as well as mine water geothermal systems. In the case of mine water geothermal systems, Nova Scotia belongs to the pioneers, as in 1988 the first fully operational geothermal mine water system in America was installed here. The first mine water geothermal system at all used mine water of the German coal mine Zeche Heinrich, Steinkohle Essen-Heisingen in 1984 with 350 kW_t to heat a pensioners home (Ofner & Wieber 2008). In Springhill, NS, warm mine water is pumped through 10 bore holes to the surface and there through heat exchangers to produce some 700 kW_t of heat power. All of the bore holes into the 4 Million m³ mine water pool are in the upper part of the flooded underground mines (down to 136 m) and extract mine water from relatively high levels of the mines with temperatures of 18—20 °C. A total of 4 buildings and a district heating system is connected to the geothermal source (Ross 1993, Jessop et al. 1995, Jessop 1998).

A mine water installation in the expected temperature range of the MinThermal project was installed in Ehrenfriedersdorf/Germany (Fig. 1). Since 1992 – with some interruptions due to the flooding process – a mine water geothermal system uses 10 °C warm mine water of a flooded tine mine. It consist of both, a heat exchanger underground and a heat pump on the surface and heated a school at the beginning of a project and currently a visitor’s mine (Rottluff 1998).

To extract heat from mine water, one of two different technical solutions might be used: geothermal probes and a doublet system with a production and an injection well. Which of those technical solutions is applicable depends on the location of the geothermal system and the needs of the end users. As Rosner et al. (2008) stated “there is most notably a lack of representative pilot projects to demonstrate the application potential and the technical ancillary conditions and consequently reduce the investment risk of such locations”. MinThermal also aims in filling this gap by demonstrating the technical potential of mine water geothermal use on Cape Breton Island and studying the investment and operating costs of such a geothermal plant (Fig. 2). Aiming in reducing the carbon foot print of the Province, the project MinThermal will examine the potential for using the mine pools of the Sydney Coal Field as a geothermal resource. To stipulate private investment the project will be based on a co-operation of local business, the municipality, and Cape Breton University’s Mine Water Research Chair.

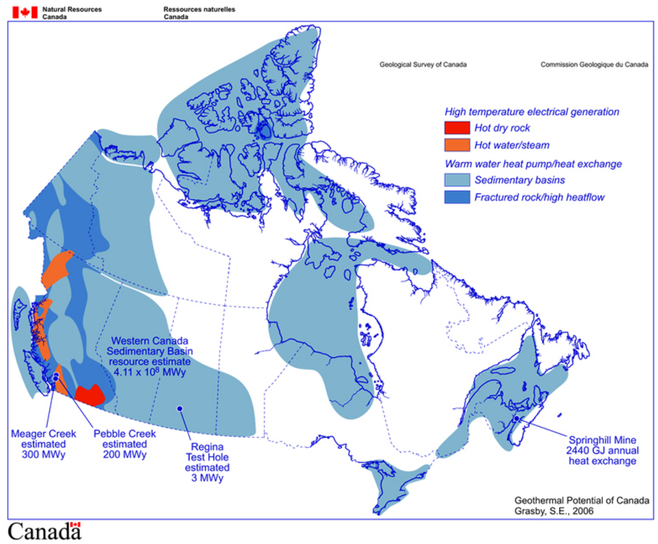

Fig. 2: Geothermal Potential in Canada (Natural Resources Canada 2006).

Literature (selection)

Arkay, K. E. (2000): Geothermal Energy from Abandoned Mines: a Methodology for an Inventory, and Inventory Data for Abandoned Mines in Quebec and Nova Scotia. – 45 S.; Calgary (Open File – Geological Survey of Canada).

GLOBE-Net – The Business of the Environment Online (2008): Geothermal – The dark horse of renewable energy (2008-01-23).

Jessop, A. M. (1998): Geothermal Energy in Canada. – Geosci. Can., (1): 33–41, 8 fig.; Waterloo.

Jessop, A. M., Macdonald, J. K. & Spence, H. (1995): Clean Energy from Abandoned Mines at Springhill, Nova Scotia. – Energy Sources, (1): 93–106, 5 fig., 2 tab.; Bristol.

Lapierre, A. B. (1999): Characterization of Discharges from Abandoned Mines of the Sydney Coalfield, Nova Scotia. – 312 p., 84 fig., 68 tab.; Halifax (unpubl. Master Thesis, Dalhousie University Daltech).

Lawson, D. C. & Sonderegger, J. L. (1978): Geothermal data-base study – Mine-water temperatures. – Special Publication – State of Montana Bureau of Mines and Geology, 79: 38, 4 fig., 1 tab., 1 app.; Butte.

Matthes, R. & Schreyer, J. (2007): Sanierung des WISMUT-Schachtes 302 in Marienberg und geothermische Nutzung des Grubenwassers. – bergbau (9): 445-446, 5 fig.

Ofner, C. & Wieber, G. (2008): Zum geothermischen Potential gefluteter Erzbergwerke: Der Geothermiekongress 2008. – p. 528–534, 2 fig., 4 tab.; Geeste (Geothermische Vereinigung – Bundesverband Geothermie e.V.).

Raymond, J. & Therrien, R. (2008): Low-temperature geothermal potential of the flooded Gaspé Mines, Québec, Canada. – Geothermics, 37: 189-210, 8 fig., 3 tab.; Amsterdam.

Rosner, P. & Demollin-Schneider, E. H. T. (2008): Gewinnung von Erdwärme aus gefluteten Steinkohlenbergwerken des Aachener und Südlimburger Reviers. – Geothermische Energie, 17 (2): 14-17, 4 fig.; Geeste.

Ross, R. (1993): Development and application of geothermal minewater energy from the abandoned coal mines in the Springhill coal fields, Springhill, Nova Scotia, Canada. – The = Canadian Conference on GIS. Proceedings, Report: 1993: 400–415.

Rottluff, F. (1998): Neue Wärmepumpenanlage im Besucherbergwerk Zinngrube Ehrenfriedersdorf. – Geotermische Energie, 6 (1): 8-11, 3 fig.; Geeste.

Rühaak, W., Schätzl, P., Renz, A. & Diersch, H.-J. G. (2008): Numerical modeling of Geothermal Processes: Issues and Examples. – Proceedings, 10th International Mine Water Association Congress: 105-108; Karlovy Vary.

6.3 Innovation and derivative applications

- Provide, in a non-technical manner, a concise overview of the underlying technology and explain the innovative aspect(s) of the resulting product(s) or service(s).
- If the resulting product or service would build capacity usable for other development activities, provide examples.

Every location on earth receives energy from two sources: the sun and the physical and chemical processes occurring within the earth itself. Whilst the sun provides heat to the first 10 to 20 meters, the physico-chemical processes within the earth heat the remaining kilometres of the of the earth's crust. Near surface systems commonly work in a temperature range of 8–12 °C, whilst deep systems can reach up to 200 °C. Geothermal Energy uses this stored heat with the help of technical installations that transport this heat into a readily usable form. Current geothermal applications, as described before, use either heat pumps or heat exchangers to make use of the stored energy, whereas the technology mainly depends on the temperature of the source. In both cases, the liquid involved is usually of relatively good quality and causes no harm to the technical installations. MinThermal will use the heat stored in flooded coal mine workings, where the water temperature is in the range of 13–16 °C. The relatively small number of about 20 working mine water based geothermal systems world-wide, compared to some 100.000 standard geothermal installations, indicates that there are still limitations of this technology. MinThermal, as a pilot project on Cape Breton Island, will introduce new innovative scientific methods to overcome those limitations by studying and installing different existing technologies to extract the heat from the source. Furthermore, by applying numerical modeling, physico-chemical studies of the mine water and studies of the water flow directions within the mine pool the most advantageous locations of production and injection wells will be derived.

Examples of where this technique and the service resulting from MinThermal can be used are multifold. Besides the 1B mine pool in Glace Bay, about 20 other mine pools are located in the Cape Breton Municipality ("Sydney") and can be used as a resource for geothermal energy. Furthermore – besides the known location at Springhill – there are several other abandoned mines in Nova Scotia or Canada where geothermal applications might be readily installed. Thus, MinThermal will build capacity both on Cape Breton Island but also at other Nova Scotian locations with abandoned mines and mine pools with an elevated temperature.

GLOBE-Net (2008), The Business of the Environment Online, summarized that fact in an article: "Canada has been slow to get into the geothermal game and [...] many industry experts believe Canada is missing a golden opportunity to tap into its vast thermal resources for electricity production, particularly in the west, and virtually all Canadian homes can utilize geothermal heating using new technology for low heat sources".

7. **Project Work Plan: 24 Points**
Provide a work plan that details the specific activities to be completed as part of the project. The work plan must include the following components:

7.1 Project time frame and methodology

- Identify key dates linked to objectives and deliverables/milestones. Include start and finish dates.
- Provide a detailed description of the proposed approach to the project, identifying for each phase the component tasks of the work.

1 Research the Geothermal Resource

For a geothermal project to be successful, a proper reservoir and geological characterization is indispensable. Therefore, the 1st work package will physico-chemically and geologically characterize the reservoir. Though the extent of the abandoned coal mine workings on Cape Breton Island is known, they are not accessible everywhere through shafts, inclines or bore holes. Therefore no detailed spatial knowledge about the mine water chemistry or the mine water temperatures at all locations are known. Furthermore there is currently no reliable indication for the potential flow direction of the mine water in the 1B mine pool. As described above, the location of the geothermal pilot project shall be a senior citizens home in Cape Breton's Glace Bay. This location is above the № 2 and № 9 mine pool in the Phalen and Harbour seems, that operated from 1911—1949, and 1939—1971, respectively (Arkay 2000). The closest monitoring bore hole is B-188, 2 km west of the location.

To monitor the geothermal potential, approximately 4 boreholes in the area of interest are needed. They have to be constructed in addition to the extraction and injection boreholes and will be used for injecting tracers and to monitor the temperature development during the pilot phase of the project. A detailed study of the available mine maps is needed to evaluate the optimal locations for those 4–6 bore holes. Furthermore those boreholes will be used to monitor and extract water samples for detailed hydrogeochemical studies of the mine water, especially in work package 7. To get a complete insight into the thermal and chemical processes in the mine pool the physico-chemical parameters shall partly be measured and monitored on-site with on-line data logging and wireless transmission to CBU. Due to the extent and the depth of the mine pool, a pumping test, as it is normally done in geothermal applications (e.g. Raymond & Therrien 2008), might not be feasible. Furthermore, the mine water might have an elevated electrical conductivity and therefore be enriched in metals and other constituents of potential concern. Thus, it is not recommended to conduct a pump test with this type of water, as the potential discharge area might be polluted. Yet, shall the water analyses reveal a good water quality, a comprehensive pump test in addition to the tracer test will be carried out. Yet, depth dependent measurements in the boreholes will show the different mine water temperatures that can be encountered at the potential location. In addition to the tracer tests and the geothermal modelling, those result will be used to calculate the total geothermal potential and the potential energy that can be extracted from the № 2 and № 9 mine pools (Fig. 3). In addition, it shall be evaluated to determine if the mine pool can also be used for storing heat during summer time when the geothermal system is used for cooling purposes using commercially available pump and compressor technology.

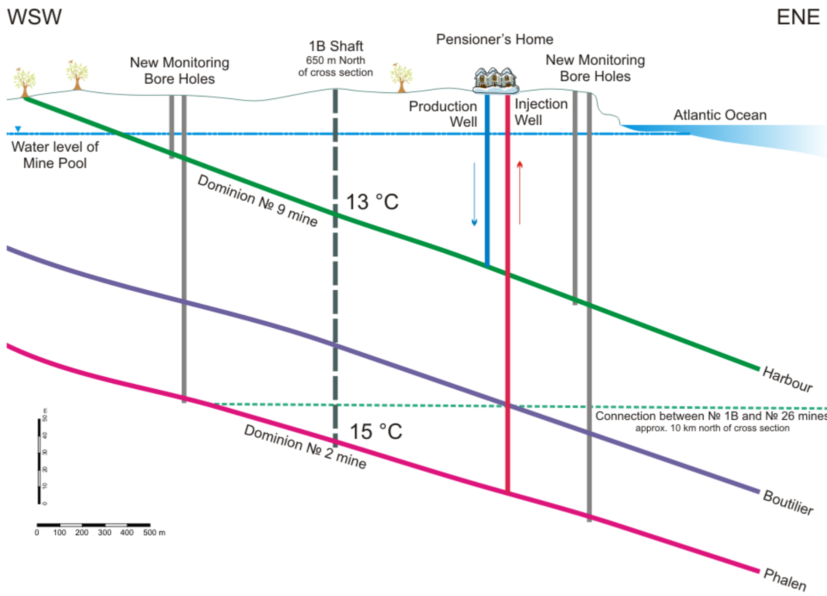

Fig. 3: Cross section of the proposed geothermal project in Glace Bay with the production, injection and the monitoring wells. Furthermore, the mine water level and the productive coal seams are shown.

2 Research the available Technology

It is known from other mine water geothermal projects (e.g. Rosner et al. 2008) that especially precipitation products, hydraulic shortcuts and unexpected flow velocities can interfere with the geothermal system and the technical installations. MinThermal will therefore especially investigate methods to improve the implementation of different technical solutions, such as geothermal probes or doublet and triplet systems. While the mine water itself will be investigated in work package 1, the type of technology shall be investigated and if necessary optimized in work package 2. A numerical model of the mine pool will be used to investigate the possible technical solutions for the project in Glace Bay. Based on the results of the geothermal modelling with FEFLOW (Rühaak et al. 2008) the optimal location for the injection and production bore holes will be determined.

During the project, different techniques to use the heat pumps and heat exchangers will be tested and optimized for being used with mine water. Especially the oxygen free flow of the water, possibly in a nitrogen atmosphere, must be ensured to avoid the precipitation of water constituents, such as Iron or Manganese or different sulphate minerals. Therefore, part of the research will be mineralogical investigations of the precipitates (e.g. metal oxides, calcium, strontium, and barium sulphate)

Within the geothermal probes, different liquids are used, such as alcohols, water or supercritical CO_2. It is necessary to calculate which of those technologies is the best for the anticipated temperature range and the depth of the geothermal application in Glace Bay. The technology itself is not the focus of this proposal as several companies word wide are improving the available technology based on the requests by the clients and the improvement of the materials engineering.

3 Investigate the necessary Capital Costs

Particular attention will be devoted to optimization of the technology for Capital Cost Efficiency so as to develop a “Modular package or system” that can be duplicated, scaled and applied to many locations and many users in Nova Scotia.

4 Calculate the expected Operational Costs

Optimization of Operational Costs will be one of the areas of focus of the project. The goal is to reach efficiencies that would see this geothermal pilot as a template for larger applications such as District Heating. It is estimated, and needs to be verified, that Operational Costs could be optimized to deliver a Heat Rate Cost of approximately 50% of the equivalent furnace oil Heat Rate Costs.

5 Examine the Environmental Challenges

Part of this work package will be to calculate the potential energy that can be extracted from the flooded coal mines of Glace

Bay. Those calculations will be based on the investigations described in the first 2 work packages and will lead to an estimation of the geothermal energy that can be produced and the subsequent footprint reduction resulting. Furthermore, this work package will be the basis for the district heating evaluation in work package 6.

Glace Bay is just one of the locations where mine water geothermal heating and cooling could be installed. Work package 5 will investigate the challenges of exporting the findings of MinThermal to other low enthalpy locations on Cape Breton Island and the Province. Expertise gathered within the project will be made available to stakeholders and interested parties in the project.

6 Investigate the potential for a geothermal district heating

The Pilot Project to be undertaken at New Aberdeen Garden Townhouses is designed to reduce to simple yearly maintenance, the cost of heating and lighting the senior's complex. No energy monthly costs other than amortization of capital expenditures will be necessary. The larger purpose of the Pilot is to perfect a system that can be applied to District Heating use for all Industrial Cape Breton.

The resource of the mine water is estimated to be sufficient to supply a District Heating system stretching from Glace Bay to Sydney Mines and incorporating the towns of Glace Bay, Dominion, New Waterford, Sydney Pier, Sydney, Sydney River, North Sydney and Sydney Mines.

We envision a private/public sector partnership which would include the proponent: Cape Breton Explorations Ltd.; the CBRM;the Province of Nova Scotia. The Province would license the Geothermal Resource to CBRM. CBRM and Cape Breton Explorations Ltd. would form a joint venture that would see private capital fund the project in stages and would see CBRM manage the infrastructure and the delivery of the Hot Water through its Water Utility.

The stages are anticipated to be:

1) Lay the main hot water pipe (backbone) from 1B mine all the way to the Glace Bay hospital , picking up those commercial enterprises that are on the way. (Kindergarten; School; Credit Union; Marconi Museum; Seniors Residence Sterling; Mike's Restaurant; Sterling Mall; Federal Government Building; Savoy Theater; Commercial Street Businesses; Miners Museum; Glace Bay Hospital; by 2012)
2) Backtrack with feeder lines to pick up all residential streets (by 2014)
3) Extend backbone to Dominion and New Waterford (2015)
4) Extend backbone to Whitney Pier and Sydney (2016)
5) Extend backbone to Sydney River and Westmount (2017)
6) Extend backbone to North Sydney and Sydney Mines (2018)

7 Monitor and optimize the Utilization of the mine water geothermal energy

Based on the monitoring results and the results of the tracer tests as well the chemical investigations, the geothermal system will be improved once new results evolve. An important part of this work package will be the modelling of the geothermally active mine pool by use of a numerical model, such as FEFLOW. Four monitoring bore holes, that can be converted to injection or production boreholes if necessary, shall be constructed to give access to the mine pool. Thos bore holes will be used to monitor the thermal and chemical development of the mine pool before and during the production phase of the project. They will furthermore be used in work package 1 to conduct the mine water tracer test for estimating the overall flow in the pool and setting up the conceptual model for the geothermal application. As it is essential to communicate the monitoring data to the local community and to interested parties, an on-line and wireless monitoring system will be installed on a web bases data management solution. This enables interested parties to use the data and to optimize similar systems by investigating the MinThermal case study more detailed.

7.2 Management structure

- Indicate roles and responsibilities for the project and, if necessary, its components. If possible, include an organizational chart.
- If more than one organization is involved, clearly detail the relationship.

The Management Team is comprised of:
Research: Prof. Christian Wolkersdorfer and his research group.
Business: Luciano Lisi and his team at Cape Breton Explorations Ltd.
Seniors Complex: Christine Kavanagh and the Garden Townhouses personnel.

7.3 Project Benefits

- Indicate how the project proponent and partners will benefit from the proposed project.
- Identify how the product or service that will result from this project will impact the targeted market, if applicable.

a. The immediate benefit to the project proponent, New Aberdeen Garden Townhouses Inc., is the ability to supply seniors with affordable, sustainable, and environmentally friendly accomodations. The double application of wind and geothermal will enable the proponent to “lock in time” the cost of heat and electricity so that while other variable costs may escalate over time, heat and electricity will remain mostly fixed.

b. Upon optimization of the “system” a real opportunity exists to expand to a full District Heating System for all Industrial Cape Breton. The system can also apply to other areas of Nova Scotia where coalfields are already known to be flooded or flooding such as Cumberland and Pictou Counties.

7.4 Economic Impact

- Detail the economic impacts of the project to the community and other stakeholders. This should include any shifts in financial pressures, as well as benefits derived from new economic opportunities. Preference will be given to projects that maximize Nova Scotia content, where applicable.
- Indicate all direct and indirect person-hours of work and/or jobs that will be created as a result of this project. Also indicate potential for person-hours of work and/or jobs that may result after the completion of the project (i.e. in the commercialization phase of a new product/service).

a. The New Aberdeen Garden Townhouses project is located in an economically depressed area of Glace Bay known as Number 2. The project will anchor a revitalization of the area. It will keep seniors in their neighbourhood and in their community. It will have direct immediate financial impact on those small businesses that will be engaged in the construction and later the maintenance of the complex. The use of Wind and Geothermal will make the project more financially feasible while keeping the cost of renting the units affordable for the target tenants: seniors and pensioners.

The project will be 100% Nova Scotia content and if achievable, at least 75% local content.

b. The overall estimates, calculated at “all in cost of person-hours inclusive of benefits” at $ 75/person-hour: approximately 13,000 person-hours for the pilot project. The overall estimates for a full District Heating application are approximately 260,000 person-hours per year.

7.5 Project location

- Indicate where in Nova Scotia your project work will take place. Provide a site map if applicable.
- Indicate where any finished product or service would be applied (regionally, provincially, nationally and internationally), if applicable.

Selecting a location for the pilot and demonstration study needs to take into account the availability of the two energy sources mine water and wind energy as well as space for building and expanding the system into a district heating application. One of those locations is Glace Bay, where the technical pilot and demonstration installations of MinThermal will be located (Fig. 4). Based on the availability of other warm mine water pools or mine water outfalls potential areas for applying the project are nearly all of the Cape Breton Municipality where mining once persisted. Assuming that only 2 % of all abandoned mine locations in Nova Scotia have the potential for geothermal energy and are within the range of settlements, roughly 100 sites might be expected in Nova Scotia.

Fig. 4: Location of the proposed mine water geothermal project MinThermal on eastern Cape Breton Island in the Cape Breton Municipality.

7.6 Risk Assessment

- Describe in detail the risks involved, including technical, financial, market, regulatory, and other relevant risks.
- Detail the proposed approach for mitigating the risks identified.
- Identify any competitors or alternatives to the product/service being proposed in this project.

Geothermal projects distinguish between two main risks: drilling risk and discovery risk. Drilling risk at Glace Bay is relatively small as drilling companies working for CBDC (Cape Breton Development Corporation) were successful in locating abandoned mine workings elsewhere. Therefore this risk can be seen as minimal. Similar issues are connected to the discovery risk. This might be negligible as it is known that the mine workings below Glace Bay are flooded and filled with water of temperatures between 13 and 16 °C. Yet, out of the potential risks, a shortcut between the production and the injection borehole is the key issue. Should the cooled mine water that is re-injected into the injection well flow too quickly back to the production well the geothermal system might fail earlier than anticipated. To avoid such a shortcut the proposed bore holes will be selected in that way that they are far away from each other and that they are drilled into two different mine aquifers. As the project will involve 4 monitoring boreholes one of those boreholes could be used as a backup once a shortcut is encountered. Another risk, yet not that imminent, is the drilling risk. A smaller risk is the risk that the owner of a property could intervene against a potential drill location. A first overlay of the available mine maps with the CBDC and municipal property showed that this risk is minimal as potential locations are on the property owned by the proponents or the stakeholders and is accessible by public roads.. Regulatory risks have been investigated by CBDC as the owner of the mine water and discussed with the Province. At the current stage of discussion the permitting authority shall be the Municipality who already indicated that the permit for using the mine water as a geothermal resource will be granted to the project. As the need for senior citizens homes in the Cape Breton Municipality is relatively high and a heating system for those houses is needed in any case, the financial risk for the project is relatively small. The main applicant has experience in building wind turbines and allocating private money to build those turbines. Therefore the risk of getting energy from a wind turbine is relatively small. Shall this part of the project fail, power from Scotia Power can be purchased to drive the heat pumps.

Potential competitors for the project would be every company that constructed the Springhill geothermal installation and every real estate company located on Cape Breton Island. Yet, the temperatures at Springhill are higher and the problems with highly mineralized and acidic mine water are smaller than at the Glace Bay location. Alternatives for the heating system would be conventional heating with oil, gas or coal, which would add to the greenhouse gas emissions MinThermal aims to reduce.

7.7 Stakeholder support (if applicable)

- Identify stakeholders that are in support of the proposed project and attach any letters of support as an appendix.
- Detail how information and results from the project will be communicated, and to whom.
- Detail the social benefits of the project to the applicant(s), the community and other stakeholders. Include any potential social disadvantages related to the project.

Stakeholders in strong support of the project are Cape Breton Development Corporation as the legal owner of the mine water, Cape Breton Municipality as the permit holder for the geothermal energy and the Community of Cape Breton as the interested party in the district heating.

Information and results of the project will be communicated through the local (Mr. Lisi has long lasting contacts to the local press) and international press (Prof. Dr. Wolkersdorfer is General Secretary of the International Mine Water Association and Editor of the international journal *Mine Water and the Environment*) as well as information meetings with the local population and by flyers and pamphlets distributed to the local community. Because some of the local first Nation's population lives above flooded mine workings as well the local first Nation's leaders will be involved as well.

Social benefits of the project will be, initially, lower rental costs all inclusive of heat and lights, for the senior tenants of the complex. If the technology is demonstrated to have feasible applications for district heating, then the social benefits are enormous as they would apply to all of industrial Cape Breton.

Cape Breton Explorations Ltd. is strongly committed to the project as evidenced by the two principal shareholders of New Aberdeen Garden Townhouses Inc. Luciano Lisi and Christine Kavanagh. Cape Breton Explorations Ltd. believes the potential for a District Heating Application in Industrial Cape Breton and elsewhere in Nova Scotia is simply extraordinary and potentially financially rewarding to the Company, The Municipality and the Community.

7.8 Marketing strategy

- If the project will result in a marketable product or service, provide a detailed marketing plan.
- Clearly identify the target market(s) and how this product/service will be marketed and delivered to them.
- Describe any educational/promotional components of the project, and how they tie in with the overall goals and objectives.

The resulting technology will be made available to the public as described by Prof. Wolkersdorfer. On the commercial aspects of the technology the plan is simply to expand the project to a full District Heating Application in partnership with CBRM and under license from the Province of Nova Scotia.

7.9 Sustainability

- Indicate how the achievements of the project will be maintained after this project is completed (e.g. who will maintain/operate infrastructure, communicate ongoing programs, etc.).
- Describe the extent to which the project can be replicated by other organizations (e.g. likelihood that knowledge, technology or practice could be implemented elsewhere).

Because the final product of MinThermal will be a standard equipment that is available on the market, the technical equipment for the geothermal heating will be maintained by companies experienced with geothermal heat pumps or exchangers. The heating system itself is standard technique and every plumber can maintain it. In a similar way the monitoring equipment will be maintained by Cape Breton University who has a generic interest in research programs that can contribute to the education of students. Ongoing programs will be communicated by all project partners and the stakeholders as they have a common interest in green technologies, especially using the mine water as a resource instead of looking at it as a waste product.

7.10 Monitoring and evaluation

- Detail how the applicant(s) will ensure accountability in the management of this project, including a plan to monitor and assess project progress measured against the milestones/deliverables indicated in 7.1.
- Indicate how the applicant(s) will evaluate the success of the project.
- Include a strategy to ensure all funding partners are well informed of project progress.

The project's success will be evaluated by regular project meetings and by information of the public as well as the Province. Furthermore, at each milestone within the project the project partners will identify the shortfalls and adopt the projects timelines accordingly.

Funding partners will be informed through the project webpage as well as personal contacts (project meetings) and e-mails. In 2010 CBU is hosting the international Mine Water Association Symposium and within this symposium, the outcomes of the project shall be demonstrated. Furthermore, the proponents hold strong networks within the building and the mining industry to guarantee a quick dissemination of results.

7.11 Intellectual Property (IP)

- For any technologies to be transferred or developed as part of the project, describe the intellectual property arrangements including the proponent's rights to, and protection for, the intellectual property required to exploit the technology involved in the project. Describe the measures which would be taken to ensure that the resulting technologies would remain in and provide continuing benefits for Nova Scotia.

Currently it is not anticipated to produce intellectual property that would not be available for all users of such geothermal systems. It is the proponent's principle that results from research financed by the public must be freely available to the public and must not be protected by intellectual property. The results of the project will therefore be published on a webpage (http://MinThermal.wolkersdorfer.info) and published in national and international journals.

8. <u>Environmental Benefits</u>: 30 Points

Provide a detailed analysis of the specific environmental impacts and benefits of the project. All information must be completed in this section or applications will be consider ineligible. The analysis must include the following components:

8.1 Emissions Reductions

Identify the air emissions reductions that will occur as a result of this project by filling in the table below.

- If the project focuses on a one-time activity (i.e. technology adoption or demonstration, upgrade, etc.), provide the annual emissions reductions to be realized on completion.
- If the project is based on a new product or service, provide the cumulative annual reductions from the current date until 2020.

	Emissions Reductions in Nova Scotia	Emissions Reductions Outside of Nova Scotia	Total Reductions
CO_2 (t)	228	–	228
SO_x (kg)	2529—4740	–	2529—4740
NO_x (kg)	502—667	–	502—667
Mercury (g)	5.0—7.3	–	5.0—7.3
Other (Particulate Matter, VOCs, etc.)	No data available	–	–

8.2 Calculations

- Using the information given in section 8.1, provide details of your calculations for greenhouse gas and air pollutant reductions including key assumptions and conversion factors.

New Aberdeen Garden Townhouses Inc.

Assumptions of Electricity use per unit (Lights Only)	3,600 kWh/Year
Total for Complex (16 Units and Common area)	63,360 kWh/Year
Assumptions of Electricity use per unit (Heat Only)	12,000 kWh/Year
Total for Complex (16 Units and Common area)	211,200 kWh/Year

Total estimated Electricity Use: Lights & Heat ***274,560 kWh/Year***

Wind Turbine (100kW; 32% Efficiency) 280,320 kWh/year

Conversions:	***Furnace Oil***	***kWh***	***BTU***
Furnace Oil	100 Liters	1,074.36	3,666,800
1 Litre of Oil		10.74	36,668
1 kWh		3,413	
Displacement of GHG:		1 MWh	280.32 MWh/Year
REC		1 Ton	280.32 Tons/Year

Please Note: 1 Megawatthour of wind is equivalent to 1 Ton of REC (Renewable Energy Certificate). REC'S are usually bundled with the electricity generated and are deemed to contain all Green House Gases. Carbon Credits are not contained in REC'S but in Nova Scotia there is currently no certification for Carbon Credits.

Mercury calculation

According to Pilgrim (1998) Lingan's annual Hg emission is 85 kg and based to http://www.ceamercuryprogram.ca/EN/NSPower/NSPICompanyandSiteInformation.pdf it is 117.6 kg and in 2008 it was 18.36 mg/MWh. Assuming that all the power would come from the Lingan Power Plant (600 MW block), a reduction of 5.0 – 7.3 g can be calculated.

CO_2, SO_x, NO_x calculation

According to http://www.ceamercuryprogram.ca/EN/NSPower/NSPICompanyandSiteInformation.pdf the following relevant data for Lingan exists:

net annual electricity generation (2001)	4,444 GWh
SO_2	76,767 t
NO_x	10,799 t

The data for 2008 (e-mail from NSPI, April 2009) was

CO_2e	0.831 tonnes/MWh
SO_x	9.21kg/MWh
NO_x	1.83kg/MWh

Hg	18.36 mg/MWh

8.3 Other environmental impacts

- Include any other possible environmental impacts, positive or negative, associated with this project (local air pollutants, fuel production, transport and storage, electricity generation and transmission, etc.). Emissions reductions potential outside of Nova Scotia will be evaluated here.

Negative environmental impacts of the project can be seen in the construction of a wind turbine and the temporal disturbance of the local community during the construction of the senior citizens home and by drilling the monitoring, the production and the injection boreholes. The latter are usually restricted to 1–2 days per bore hole. Furthermore, during the project, cars have to drive to the monitoring boreholes to inspect the equipment and to take water samples. As the wind turbine will be just 400 m away from the proposed project, an underground power cable instead of a surface transmission cable will be constructed. A minor negative impact comes from the fact that part of the research facility will be on site and cars and equipment will drive to the location. Yet, this would also be the case would a conventional heating system be installed. Positive environmental impacts are the reduction of greenhouse gases, the use of local resources and the use of wind energy to drive the whole electricity part of the geothermal system, especially the heat pumps.

The pilot project will have the immediate environmental impact of displacing ALL fossil fuels that would otherwise be used to heat and supply electricity in a complex of this type. The project plans to apply for EcoLogo certification.

9. <u>Project Budget</u>: 20 Points

9.1 Project Expense Summary

Provide a summary of the project expenses using the following table. Create new rows for expense categories if necessary. Please review the Environmental Technology Program Guideline for details on eligible costs, funding guidelines and other requirements. Remember:

- The ETP will provide funds to a maximum of 50% of total project costs.
- The project proponent must commit to a minimum cash investment of 20%.
- Salaries/wages attributed to the project proponent or partners must be claimed at cost and will be considered a cash contribution. Salaries/wages of those in a management/owner position are considered ineligible.
- The ETP will support only the <u>incremental costs</u> of equipment that will reduce air emissions.
- Administration costs cannot exceed 10% of project costs.

Expense Category	Expense Details		ETP Request	Other Sources	Total Project Costs
	Cash	In-kind			
Human Resources (*salary/wages, etc.*)	$ 428,220	$	$ 171,288	$ 256,932	**$ 428,220**
Professional Fees (*technical, consulting, legal, contracting, etc.*)	$ 124,000	$	$ 49,600	$ 74,400	**$ 124,000**
Equipment/Supplies	$ 679,500	$	$ 271,800	$ 407,700	**$ 679,500**
Equipment Rental	$ 15,000	$	$ 6,000	$ 9,000	**$ 15,000**
Administration Costs	$ 45,000	$	$ 18,000	$ 27,000	**$ 45,000**
Travel Costs	$ 21,400	$	$ 8,560	$ 12,840	**$ 21,400**
Other (*please specify*)	$ 54,182	$	$ 21,672	$ 32,509	**$ 54,182**

TOTALS	**$1,367,302**	**$**	**$ 546,921**	**$ 820,381**	**(A) $ 1,367,302**

9.2 Project Expense Details

Provide the details of the expenses summarized in 9.1. Be as specific as possible, including payroll expenses for all employees involved, justification of consulting fees, exact equipment costs, etc. Provide expected payback periods for equipment purchases.

Expense Category	Expense Details	Total Costs
Human Resources (*salary/wages, etc.*)	Covers 1 full time researcher for the monitoring and modelling, ½ researcher for maintaining the monitoring equipement, and ½ researcher for tracer tests; Human Resources are students (11,100 CAD), 1 full time researcher (43,600 CAD), 1 half time researcher (21,800 CAD) and one half time Professor (60,000 CAD). AN annual salary increase of 4.5 % has been added to years 2 and 3.	$ 428,220
Professional Fees (*technical, consulting, legal, contracting, etc.*)	Professional Fees will be fees for having the water samples analyzed for metals through ICP-MS and isotopic studies (e.g. Sr, O, D) and the drilling of the 4 monitoring bore holes (40, 130, 190, and 260 m deep).	$ 124,000
Equipment/Supplies	Equipment will be probes for monitoring boreholes (e.g. electrical conductivity, oxygen content, pH, temperature), data samplers for the field, probes chemical analyses (ion chromatography). The wind portion of the application includes 1 Northwind 100KW turbine on a 32 meters tower, conduits, Low Voltage Ride Through, Control Cabinets, Inverters, Safety Gears Etc.	$ 679,500
Equipment Rental	Rented equipment will be cars to travel to the sites with heavier equipment and to transport samples to the laboratories	$ 15,000
Administration Costs	Accounting, Auditing, Bookkeeping, Bank Service and Interest Charges, Legal, Insurance, Certifications etc.	$ 45,000
Travel Costs	The monitoring bore holes and the geothermal system have to be sampled and controlled on a regularly basis. Furthermore, there will be project meetings at least twice a year and the visit of an international and a national conference in the project.	$ 21,400
Other (*please specify*)	Consumables will be for example chemicals for on site analyses, bottles for taking samples, gases for TIC/TOC analyses, tracers, chemicals for tracer analyses, storage tools, data transfer and storage. IN the second year experiments with the heat exchanger are anticipated.	$ 54,182
		(B) $ 1,367,302

9.3 Funding Source Details

Provide details of the project funding sources using the following table. Include all confirmed and not confirmed sources of funding. Create new rows for additional funding sources if necessary.

Funding Source	Cash	In-Kind	Confirmed? (Y/N)	Total
Environmental Technology Program *(indicate request)*	$ 546,921		N	$ 546,921
CBDC		$100,000	Y	
ECBC	$ 546,921		N	$ 546,921

Proponent	$ 273,460		Y	$ 273,460
Total	**$ 1,367,302**	**$**		**(C) $ 1,367,302**

Totals for columns (A), (B) & (C) should be equal.

9.4 Public Funding Contacts

If the applicant is receiving, or has applied for, funds from another public organization (a municipal, provincial or federal government department, agency, Crown Corporation, etc.) for this project, please provide fill in the chart below:

Funding Organization	Contact Name	Contact Phone Number	Contact Email Address
– ECBC	Joe Cushin		
–			
–			

9.5 Environmental Technology Funding History

Has the applicant received funding from any provincial government program, department or agency within the past two years specifically related to the objectives of the ETP? If yes, fill in the following table:

Department/Agency/Program from which funding was received and contact information	**Funding Amount**	**Date Received**	**Purpose** (provide a brief description of the project/activity)

The Province reserves the right to perform a credit check on the project proponent and/or partnering organizations and/or require financial security (performance bond, letter of credit, etc) be submitted by the same.

<u>Attachment Checklist</u>

The following attachments must be submitted before ETP funding can be approved:

- ☑ A copy of the Annual Report for the past fiscal year of all organizations contributing financially to the project.
- ☑ A letter confirming participation from <u>each</u> organization contributing financially or in-kind to the project.
- ☑ CV's of those who will be contributing directly to the project, including references from relevant work.
- ☑ Any project plans, business cases, strategies, marketing plans or other documents directly relating to the proposed project.
- ☑ Documents confirming regulatory approval - if applicable.
- ☑ Provide any additional information relevant to this project as an attachment. Clearly indicate additional attachments in the space below.

1)

Cape Breton Explorations Ltd.

292 Charlotte Street, Suite 101, P.O. Box 244, Stn. A, Sydney, N.S. B1P 6H1
Tel: (902) 539-0147 • **Fax:** (902) 539-4143

Corporate Overview

Executive Summary

Cape Breton Explorations Ltd. (CBEX) – is a private, renewable energy development company operating in Atlantic Canada. The founders of the company have a track record of developing wind projects and have developed and built the 17.3 MW Enercon wind farm at Lingan, Nova Scotia. All future renewable energy projects developed by this team will be developed as CBEX projects.

CBEX is currently working on several medium and large renewable energy projects with a focus on Atlantic Canada. This region is blessed with natural resources, which are ideal for wind, tidal, hydro, biomass and natural gas development. It is also in close proximity to the New England market, which is home to 14 million people who import 90% of their energy requirements from their neighbors, including Canada. Atlantic Canada has a natural gas pipeline connecting to Massachusetts, and electric transmission facilities, which connect hydro, nuclear, gas, oil and wind energy into the New England area. Atlantic Canada is home to Canada's largest oil refinery and has an LNG terminal under construction, both of which service New England.

The CBEX business model is to be a development company, which develops projects, retains a carried interest in those projects and provides ongoing O & M.

1) CBEX is currently developing a 250 MW wind /hydro pumped storage facility through its subsidiary Cape Breton Hydro Ltd.
2) A 60 MW biomass generating facility through its subsidiary CBEX Renewable Energy Inc.
3) A single wind turbine installation at Cape Breton University through its subsidiary CBEX Distributed Energy Systems Inc.
4) A wind turbines bid for NSPI's new RFP on distribution.

Corporate Structure

CBEX is a private company formed in 2004 to be a development company of renewable energy projects.

Personnel

See 5.3

Active Projects

Wind/Hydro

(Cape Breton Hydro Ltd.)

CBEX's current primary focus is the development of the 250 MW wind/ hydro Pumped Storage project – Cape Breton Hydro Ltd. is a subsidiary of CBEX. The project consists of two 75 MW Hydro Reversible Pump Turbines supported by 44 wind turbines E 70 X 2.3MW used for off peak pumping. The Hydro Generating Facility is estimated to generate approximately 400,000 MWH per year, generating at full output but only 6 to 7 hours per day at peak demand.

The Site consists of approximately 15km by 4km of forestlands at East Bay Hills, Cape Breton. The land is zoned for forest use and CBEX is in the process of negotiations for the purchase of approximately 375 acres, sufficient for the Upper Reservoir, for the Hydro Facility and with access to Lake Uist and a long term lease agreement for the wind turbines with the landowner: The Nova Scotia Department of Natural Resources.

The energy produced by the facility will be sold to ISO New England (NEPOOL), through an Energy Marketing Agreement with Emera Energy Services and local users, which may include Nova Scotia Power and Municipal Utilities and in the future, may include Transmission Connected customers, upon further opening of the electricity market.

Distributed Energy Applications: wind turbines.

(CBEX Distributed Energy Systems Inc)

CBEX is currently engaged with a number of clients and expects to finalize several additional contracts for" Behind the Meter" applications in the under 2 MW "small wind" category. Typically 1 or 2 Enercon E48 (800 kW) with or without partial battery storage possibilities for peak shaving. The applications are customized in each case to suit the customer's needs. The first single turbine system to be installed is for Cape Breton University. The system is made of 1 Enercon E 48 × 800 kW Wind Energy Converter to be erected on campus before the end of 2009.

Utility Scale Biomass:

(CBEX Renewable Energy Inc.)

60 Mw Biomass Power Generating Facility using forestry wood waste.

Other Projects in Development:

The CBEX team is currently developing other renewable energy projects, which include:

- Wind development: bid on the new NSPI Distribution Level RFP.
- Energy Storage.
- Otec (Ocean Thermal Energy Conversion).
- District Heating/Geothermal.
- Flue Gases Heat recovery Conversion Systems.

Proposal Submission

Submit the completed proposal and all attachments electronically to:
ecoNova Scotia Fund Coordinator, Environmental Technology Program
ecoNovaScotia@gov.ns.ca

If you are unable to submit electronically, please contact the Fund Coordinator at the below coordinates:
Department of Environment, Environmental and Natural Areas Management Division
ecoNova Scotia for Clean Air and Climate Change
5151 Terminal Road, 5th floor
PO Box 442 Halifax, NS B3J 2P8
Ph: (902) 424-8269 Fax: (902) 424-0503
ecoNovaScotia@gov.ns.ca
http://www.gov.ns.ca/ecoNovaScotia

You will receive an acknowledgement that we have received your application via e-mail.

For assistance with your application, or for any questions you may have, please contact us.

CONFIDENTIALITY STATEMENT

All information submitted to the Government of Nova Scotia as part of an application to the ecoNova Scotia for Clean Air and Climate Change will be governed by the provisions of the Freedom of Information and Protection of Privacy Act (http://www.gov.ns.ca/legislature/legc/statutes/freedom.htm). Any information submitted will be retained by the Government of Nova Scotia.

CAPE BRETON DEVELOPMENT CORPORATION

SOCIÉTÉ DE DÉVELOPPEMENT DU CAP-BRETON

April 30, 2009

EcoNova Scotia for Clean Air and Climate Change
5151 Terminal Road
P.O. Box 442
Halifax, N.S. B3J 2P8

Dear Sir/Madam:

The Cape Breton Development Corporation (CBDC), a federal Crown corporation, has been involved with mining-related activities in the Sydney, Nova Scotia, area since 1967. Throughout the period 1967 to 2001, CBDC, or Devco as it was known locally, operated a fully integrated coal mining activity involving several mines; a railway, truck and port transportation system; a coal preparation and storage facility and marketed its coal products both in Canada and internationally. In 2001 CBDC discontinued its mining activities and began addressing obligations associated with closure of the business.

The closure of the mines resulted in natural flooding of the mine openings by surface drainage and groundwater. CBDC is responsible for managing potential mine water discharges in these mine workings and through the investigation process, the Corporation discovered that there was a tremendous energy source in the mine water. Active discussions ensued with the private sector and various provincial government departments, in particular Natural Resources, Energy, Education, and Conserve Nova Scotia. The Corporation expressed its view that research is required to determine how this resource can be developed to supply economical, clean energy to schools, hospitals, office buildings and other infrastructure in the area.

Developing the clean energy initiative using the mine water in abandoned mine openings is a project that would align with a Legacy initiative CBDC has been developing as part of its Strategic Plan. The Legacy component involves using redundant assets for the benefit of the community. Therefore, the Cape Breton Development Corporation supports the interest of the New Aberdeen Garden Townhouses Inc. and Cape Breton University in their proposal to conduct the research that will ultimately develop an optimized technology for extracting the clean energy from the mine water in many of the abandoned mines in the Sydney Coalfield. A project of this nature can benefit Nova Scotia through helping the province to meet its obligation to reduce greenhouse gas emissions and, at the same time, the knowledge gained related to this home-grown technology will be made available to other abandoned mine sites throughout Canada.

In the Corporation's view, this research will greatly enhance Canada's green energy image.

Yours truly,

Robert J. MacDonald, M.Sc, P.Eng.
Director General - Property and Environment

Cape Breton District
HEALTH AUTHORITY

Making Healthier Choices Together

Cape Breton Regional Hospital
1482 George Street
Sydney, Nova Scotia
B1P 1P3

April 29, 2009

ecoNova Scotia for Clean Air and Climate Change
5151 Terminal Road
PO Box 442
Halifax, NS B3J 2P8

Dear Sir/ Madam

The Cape Breton District Health Authority is very pleased to offer its support to the project proposed by New Aberdeen Garden Townhouses Inc. and Cape Breton University, to research the issues surrounding utilization of minewater for geothermal energy. This is an issue of distinct importance to the Cape Breton District Health Authority, as we ourselves are also interested in the possibility of taking advantage of the energy potential of the warm water in the former mine workings directly below our facility and have recently completed a study of the feasibility of applying this technology to the Glace Bay Hospital. Some of the issues being addressed by this research project, including system design, components selection, and water flow, will be direct relevance to our own geothermal objectives and we very much look forward to learning from the research done under the auspices of this project. We also see this as benefitting the health of the people and environment of Cape Breton by ensuring not only our facilities but also others in the community as well, use green energy and become a healthier place to visit and work.

Best regards

Jim Merkley
Vice President Diagnostic & Support Services

Prof. Dr. Ch. Wolkersdorfer

Cape Breton University
Chair in Mine Water Remediation & Management
P.O. Box 5300
Sydney, Nova Scotia, B1P 6L2
CANADA
E-Mail: c.wolke@cbu.ca

Curriculum Vitae

Date of birth	:	February 17 1964
Place of birth	:	Schwabach/Mfr., Germany
Citizenship	:	German
Personal status	:	married
languages	:	German, English, French

Membership and Functions

IMWA International Mine Water Association (Secretary General)

PADRE Partnership for Acid Drainage Remediation in Europe (Secretary General)

IAH International Association of Hydrogeologists

DGG Deutsche Geologische Gesellschaft

BDG Berufsverband Deutscher Geowissenschaftler

VFMG Vereinigung der Freunde der Mineralogie und Geologie

Bergwerksverein Silberleithe Tirol (Scientific Advicer)

Associated Editor Europe „Mine Water and the Environment“

Education

1970 – 1974	public school, Wendelstein
1974 – 1975	secondary school, Wendelstein
1975 – 1984	high school, Roth
1984 – 1986	University of Erlangen-Nürnberg, Germany; study of Geology
1986 – 1989	Technical University of Clausthal, Germany; study of Geology
1989	Diploma Thesis on alpine lead-zinc-deposits
1995	PhD Thesis Hydrogeochemistry of a flooded Uranium mine

National service

1990	Air force geological survey Karlsruhe, Germany

Professional experience

1989	computer operator, Quelle, Germany

1991 – 1995	research assistant of Prof. G. Reik, Ph.D., TU Clausthal
	(Department of engineering geology), Germany
	Graduate studies in Hydrogeology at the TU Clausthal.
1995 – 1999	*IFG* – Ingenieurbüro für Geotechnik mbH Bautzen, Germany
1999 – 2006	TU Bergakademie Freiberg, Department of Hydrogeology, Germany
2006 – 2008	LMU Munich, Full Professor for Hydrogeology, Germany
2008 –	Cape Breton University, Canada

Professional experience – projects (selection)

1. Mapping of the western Mieminger Mountains
   Austria; 1989
2. Air Force, Geological Survey;
   Different Environmental Projects; Oil Contamination; Petrol Stations 1990
3. Ion mine Nammen Westfahlen
   Core Logging, 1991
4. Bürgerinitiative Moringen
   Consulting Work for Rubbish Tip Planing; 1992
5. Bürgerinitiative Altdorf-Burgthann
   Geological Investigations for a Rubbish Tip Planning; 1992
6. Geological Institute Clausthal
   Mapping in Commune Brønnøy, Norway; 1992
7. Wismut GmbH Chemnitz
   Geochemical Investigations in an abandoned Uranium mine, 1993
8. DFG, Bonn (research project);
   Flooding of the abandoned Uranium Mine Niederschlema/Alberoda;
   1992 – 1994
9. Forestry Bad Grund, Niedersachsen
   Slope Stability Investigations and Stress Measurements at Jung Quarry, 1993 – 1994
10. Forestry Bad Grund, Niedersachsen
    Recultivation and Mining Plan; 1994
11. Fa. Curator Immobilien Management GmbH
    building site investigation, 1994
12. Hydrogeologie Nordhausen (1994)
    Soil mechanical investigations for Motorway A20
13. Wismut GmbH Chemnitz (1995)
    Monitoring of flooding process, hydrogeochemical and hydrodynamic investigations in a flooded Uraniuim Mine
14. St. Carolus-Krankenhaus Görlitz (1996)
    Hydrogeological Expert Report
15. *IFG* – Ingenieurbüro für Geotechnik Bautzen (1996—1999)
    Hydrogeological Expert Reports, Soil Mechanical Investigations, Environmental Assessments

16. Staatliches Umweltfachamt Bautzen (1996; 1997)
    Geological Mapping at Motorway A40
17. Gesellschaft für Materialprüfung und Baustofforschung mbH Berlin (1997)
    Evaluation of Building Damages in Relation to an Open Pit Mining Site
18. Umweltamt der Stadt Görlitz (1997)
    Hydrogeological Investigations about potential Precipitation Infiltration
19. Deutsche Bahn AG (1997)
    Soil mechnical investigations to investigate Damages and Environmental Pollution at the Railway line Zeithain—Elsterwerda including LAGA-Investigation
20. Baufirma Rudolf (1997)
    Environmental Assessment and Working Plan for a Gravel Open
21. Gesellschaft für Materialprüfung und Baustofforschung mbH Berlin (1997)
    Evaluation of potential Building Damages in Relation to an Open Pit Mining Site
22. Deutsche Bahn AG (1998)
    Soil mechnical investigations to investigate Damages and Environmental Pollution at the Railway line Görlitz—Dresden including LAGA-Investigation
23. Martin-Ulbrich-Haus gGmbH Rothenburg, OL (1998)
    Soil Mechanical Investigations and possibilities for Precipitation Infiltration
24. Gemeinde Hochkirch, Kreis Bautzen (1998)
    Soil Mechanical Investigations for a Wastewater Treatment Plant
25. Straßenbauamt Bautzen (1998)
    Soil Mechanical Investigations for an Animal Tunnel under the Road Tröbigau—Putzkau
26. Harald Kellner GmbH (1998)
    Environmental Assessment and Working Plan for a Gravel Open
27. Siemens AG Görlitz (1998)
    Soil Mechanical Investigations for a Waldrich Coburg PMC 5000
28. Wassergemeinschaft Meschwitz (1999)
    Planning of a Drinking Water Treatment Plant
29. BST Mansfeld GmbH (2000)
    Multi Tracer Test Straßberg Harz
30. Montanwerke Brixlegg AG, Österreich (2000—2002)
    Hydrogeochemical Investigations at the former Schwaz Silver Mine
31. Výzkumný Ústav pro Hnědé Uhlí a.s. Most/Tschechische Republik (2002)
    German legislation regarding mine water drainage within the European legislative framework
32. IRGO Consulting d.o.o., Slowenien (2002)
    Hydrogeochemical development of uranium concentrations in the mine waters of the uranium mine Žirovski vrh/Slovenia
33. Gesellschaft zur Verwahrung und Verwertung von stillgelegten Bergwerksbetrieben mbH – GVV, Sondershausen (2003)
    Multi Tracer Test Straßberg Harz (2nd Test)
34. Bezirksregierung Magdeburg/Geomontan GmbH (2003)
    Planning of a Constructed Wetland for the Mine Water Treatment Plant Gernrode/Harz

35. Internationales Troia Projekt, Tübingen – Cincinnati (seit 2001)
Ground Water Recharge and Modelling of the hydrogeological and hydrogeochemical Situation within the Historical National Park Troia/Turkey
36. 5. Forschungsrahmenprogramm der Europäischen Kommission (2000—2003)
PIRAMID – Passive in-situ Remidiation of Acid Mine/Industrial Drainage (Vertragsnummer EVK1-CT-1999-00021)
37. 5. Forschungsrahmenprogramm der Europäischen Kommission (2001—2004)
ERMITE – Environmental Regulation of Mine Waters in the European Union (Vertragsnummer EVK1-CT-2000-00078)
38. Zinnerz Ehrenfriedersdorf (2004)
Multitracertest at the Tiefer Sauberger Adit, Ehrenfriedersdorf, Erzgebirge
39. CoSTaR: 6. Forschungsrahmenprogramm der Europäischen Kommission (2004)
TracePasS – Tracer Tests in Passive Mine Water Treatment Systems

Grants

Grant from the Tyrolian State Government 1989

Grant from the Raiffeisenbank Ehrwald/Tyrol 1989

Grant from the local Government Ehrwald/Tyrol 1989

Graduate Grant from the Hanns-Seidel-Stiftung Munich 1993/94

Teaching

Technical University of Clausthal, Germany

Department of General Geology (1988–1989)

- exercises in tectonics

Department of Engineering Geology (1990–1995)

- mapping in engineering geology
- laboratory work in soil mechanics
- geological seminar for undergraduates

Technical University Bergakademie Freiberg, Germany

Department of Hydrogeology (1999–2006)

- geological seminar for undergraduates
- tracer tests in mines
- mine water hydrogeology

Ludwig-Maximilians-University Munich, Germany

Department of Hydrogeology (2006–2008)

- introduction ot hydrogeology

- introduction to environmental geochemistry
- hydrogeology II
- tracer tests in mines
- mine water hydrogeology

Supervised Diploma Thesis (selection)

- Martin Albers (1990)
  Geologische und lagerstättenkundliche Untersuchungen in der Umgebung des Schachtkopfes östlich von Biberwier (Mieminger Kette/Tirol) mit einer Kartierung im Maßstab 1 : 10 000.
- Peter Lauber (1991)
  Gelogische Aufnahme eines Ausschnitts der Lermooser Mulde in den östlichen Lechtaler Alpen mit einer Karte im Maßstab 1 : 10 000 und Geologische Untersuchungen der Abfalldeponien der Ortschaften Biberwier, Lermoos und Ehrwald unter dem Aspekt der Altlastensanierung.
- Bernd Lawiszus (1991)
  Biogeochemische Untersuchungen im Bereich der westlichen Mieminger Kette/Tirol mit einer geologischen Kartierung im Maßstab 1 : 10 000 der Puitentalzone südlich des Wettersteingebirges
- Johann Tebbe (1991)
  Über die Beziehungen zwischen Tektonik und Vererzungen im Mieminger Gebirge mit einer geologischen Kartierung im westlichen Mieminger Gebirge im Maßstab 1 : 10 000.
- Florian Werner (1992)
  Tektonische und stratigraphische Untersuchungen des norischen Hauptdolomit und dessen bituminosen Einschaltungen mit einer geologischen Kartierung im Maßstab 1 : 10 000 in den Lechtaler Alpen/Tirol.
- Richter Armin (1992)
  Geologische Untersuchungen des Zugspitzgebietes und seines NW' Vorlandes in den Nordtiroler Kalkalpen mit einer geologischen Kartierung im Maßstab 1:10000.
- Udo Wirth zur Osten (1993)
  Einfluß der Lagerstättenverhältnisse und der Petrographie auf die Anlage der horizontalen und vertikalen Auffahrung von Kalisalzbergwerken in Sachsen Anhalt.
- Katharina Frick (1993)
  Untersuchungen zur möglichen Beeinträchtigung des Grundwassers durch die Deponie Erdmannsdorf, Landkreis Stadtroda mit der geologischen Kartierung von Teilen der Blätter 1305 — 233, 1305 — 234, 1305 — 412 der topographischen Karte Maßstab 1 : 10 000 im Umfeld der Deponie Erdmannsdorf.
- Jörg Lahmeyer (1994)
  Untersuchungen zur möglichen Beeinträchtigung des Grundwassers durch eine ehemalige Deponie bei Reichenbach, Landkreis Stadtroda.
- Rainer Wolf (1995)
  Der Wiederanstiegsprozeß des Grubenwassers bei der Flutung von Bergwerken.
- Bernd Schreiber (1995)
  Geologische Kartierung südwestlich von Logatec/Slowenien.

- Rüdiger Schecke (1995)
  Geologische Kartierung nordöstlich von Logatec/Slowenien.
- Olaf Flickinger (1997)
  Untersuchungen zur Regenwasserversickerung in Görlitz, Ortsteil Klingewalde.
- Helga Kraus (1999)
  Hydrodynamische Verhältnisse im Flutungswasser eines Uranbergwerks – Beschreibung von Tracerversuchen und analytischen sowie numerischen Modellierungen.
- Mario Kansy (2000)
  In situ und on site Techniken zur Reduzierung des Schadstoffaustrages von Erzbergwerken
- Andrea Hasche (2001)
  Multitracerversuch in einem gefluteten Bergwerk – Vorbereitung, Durchführung, Auswertung
- Katy Unger (2002)
  Hydrodynamische Verhältnisse im gefluteten Unterbau des Bergkwerks Großkogel/Tirol – Numerische Modellierung mit ANSYS-FLOTRAN
- Thomas Wackwitz (2002)
  Multitracerversuch im gefluteten Blindschacht des Bergwerks Großkogel/Tirol: Vorbereitung, Durchführung und GIS unterstützte Auswertung
- Sylvana Tamme (2002)
  Naturnahe Reinigung kontaminierter Bergwerkswässer – Bemessung und Entwurf eines konstruierten Feuchtgebietes bei Gernrode/Harz
- Daniela Lieber (2003)
  Säure- und Basekapazität – Vergleich unterschiedlicher vor-Ort-Bestimmungsmethoden bei unterschiedlichen Bergwerkswässern und Bearbeitern
- Tina Neef (2003)
  Hydrogeochemischen Verhältnisse in einem natürlichen Feuchtgebiet zur passiven Grubenwasserreinigung
- Katrin Bergmann (2003)
  Geologische Verhältnisse der Neogenen Sedimente zwischen Troia und Gökçali/Türkei
- Pia Lippmann (2003)
  Geowissenschaftlich-Montanistische Untersuchungen an der Quellhöhle („Kaskal.Kur") Troias
- Claudia Blume (2003)
  Hydrogeologisches Modell der östlichen Troas/Türkei
- Claudia Weber (2003)
  Hydrogeologische Verhältnisse der östlichen Troas/Türkei
- Steffi Schindler (2003)
  Hydrogeochemische Untersuchung des Grubenwassers im Hagenbachtal bei Gernrode/Harz
- Jörg Simon (2003)
  Konzipierung einer passiven Grubenwasserreinigungsanlage im Hagenbachtal bei Gernrode/Harz

- Sandra Kahl & Holger Komischke (2004)
  Tracertest im Bereich des Besucherbergwerks Felsendome Rabenstein/Chemnitz
- Judith Hultsch (2004)
  Hydrodynamische und hydrogeochemische Untersuchungen im gefluteten Bereich des Besucherbergwerks Felsendome Rabenstein
- Maren Gerstenberg (2004)
  Behandlung saurer Sümpfungswässer der Hartsteinwerke Großthiemdorf/Brandenburg
- Jörg Winkler (2006)
  Halden in Freiberg und Brand-Erbisdorf.
- Lenar Sultanov (2006)
  Application of supercritical CO_2 for the extraction of geothermal energy in deep crystalline systems.
- Judith Hultsch (2006)
  Tracerversuch im gefluteten Kalksteinbergwerk Felsendome Rabenstein – Hydrochemische Untersuchungen und hydrodynamische Modellierung mit ANSYS/FLOTRAN.
- Thorsten Genske & Thomas Kohl (2006)
  Konzipierung einer passiven Behandlungsanlage (RAPS) für saure Sümpfungswässer der Hartsteinwerke Großthiemig/Brandenburg.
- Johannes Linde (2007)
  Untersuchungen zur Kühlwasserversickerung am Geothermiekraftwerk Unterhaching.
- Fabian Henkel (2007)
  Natürliche CO_2-Vorkommen in Deutschland.
- Nico-Felice Vogdt (2007)
  Grubenwasseraustritte und potentielle Grundwassergefährdungen in Bayern – Mittelfranken, Unterfranken, Schwaben.
- Stefan Oertel (2007)
  Grubenwasseraustritte und potentielle Grundwassergefährdungen in Bayern – Oberbayern.
- Carole Kubiak (2007) – Université de Rennes 1
  Characterisation of Low Density Sludge Storage in a flooded Underground Mine.
- Christiane Neumann (2007)
  Ermittlung der Hydrodynamik mit Hilfe von Tracertests im Richtschacht Reiche Zeche/Freiberg(Sachsen).

Congresses and lectures (selection)

- Uppsala (Schweden), 2nd International Symposium on Environmental Geochemistry, 1991.
- Ljubljana/Pörtschach (Slowenien/Österreich), 4th International Mine Water Association Congress, 1991.
- Canberra (Australien), International Volcanological Congress, 1993.
- München (Deutschland), Hanns-Seidel-Stiftung, 1993.
- Kraków (Polen), 3rd International Symposium on Environmental Geochemistry, 1994.
- Nottingham (Großbritannien), 5th International Mine Water Association Congress, 1994.

- Perth (Australien), 12th Australian Geological Convention, 1994.
- Perth (Australien), CSIRO, 1994: Flooding of an abandoned Uranium Mine in the Erzgebirge/Saxonia/ Germany.
- München (Deutschland), Hanns-Seidel-Stiftung, 1994: Trinkwasservorkommen und deren Gewinnung.
- Melbourne (Australien), Monash-University, 1995: Changes in Mine Water Geohydrology during the Flooding of an abandoned Uranium Mine in the Erzgebirge/Saxonia/Germany.
- Freiberg (Deutschland), Uranium-Mining and Hydrogeology, 1995.
- Miskolc (Ungarn), Miskolci Egyetem, 1995: Flooding of a Uranium Mine – Environmental Problems and Geochemical Conditions.
- Bautzen (Budyšin, Deutschland), IFG, 1997: Neue Wege für Niederschlagswasser – Hydrogeologische Untersuchungen zur Regenwasserversickerung in Ostsachsen.
- Portorož (Slowenien), 7th International Symposium on Water Tracing, 1997.
- Bled (Slowenien), 6th International Mine Water Association Congress, 1997.
- Johannesburg (Südafrika), International Mine Water Association Symposium, 1998.
- Freiberg (Deutschland), Uranium-Mining and Hydrogeology II, 1998.
- Sevilla (Spanien), International Mine Water Association Congress, 1999.
- Ustroń (Polen), 7th International Mine Water Association Congress, 2000.
- München (Deutschland), XXXI. IAH Congress, 2001.
- Belo Horizonte (Brasilien), International Mine Water Association Symposium; Brazilian Mining Conference 2001.
- Nottingham (England), Mine Water Hydrogeology and Geochemistry, 2001.
- Kattowitz (Polen), 2nd Image-Train cluster meeting, 2002
- Lake Orta (Italien), Mine and quarry waste – The burden from the past, 2002
- Lausanne (Schweiz), M-WINE initial meeting, 2002
- Freiberg (Deutschland), Uranium-Mining and Hydrogeology III; International Mine Water Association Symposium, 2002.
- Johannesburg (Südafrika), 8th International Mine Water Association Congress, 2003.
- Freiberg (Deutschland), 3. Altbergbaukolloquium, 2003.
- Cairns (Australien), James Cook University, 2004: Tracer Tests in Flooded Underground Mines.
- Jena (Deutschland), Friedrich-Schiller-Universität, 2004: Troia – Hydrogeologische Untersuchungen im Historischen Nationalpark.
- Freiberg (Deutschland), 55. Berg- und Hüttenmännischer Tag, 2004.
- Newcastle (England), International Mine Water Association Congress, 2004.

Publications (selection, *reviewed)

- Hasche, A. & Wolkersdorfer, Ch. (2004): Mine Water Treatment with a Pilot Scale RAPS-System. – Wissenschaftliche Mitteilungen, 25: 93—99, 8 fig., 1 tab.; Freiberg.

- *Kroll, A., Amezaga, J. M., Younger, P. L. & Wolkersdorfer, Ch. (2002): Regulation of Mine Waters in the European Union: Contribution of Scientific Research to Policy Development. – Mine Water and the Environment, 21 (4): 193—200, 1 tab.; Berlin.

- *Reik, G. & Wolkersdorfer, Ch. (1999): Flutungsprognose eines Uranbergwerks — Hydrogeochemische und hydrodynamische Untersuchungen. – In: Gesellschaft für Umweltgeowissenschaften: Ressourcen-Umwelt-Management — Wasser, Boden, Sedimente. – S. 55—71, 5 fig., 5 tab.; Berlin u.a. (Springer).
- Wolkersdorfer, Ch. (1991): Geschichte des Bergbaues im westlichen Mieminger Gebirge/Tirol. – Aufschluss, 6: 359—379, 18 fig.; Heidelberg.
- Wolkersdorfer, Ch. (1991): Aufschluß an einem Tomahügel des Fernpaßbergsturzes/Tirol. – Jb. Geol. B.-A., Heft 2: 439—441, 2 fig.; Wien.
- Wolkersdorfer, Ch. (1992): Sanierung der Wismut-Uranbergwerke. – Wasser, Luft und Boden, 6: 28—29, 1 fig.
- Wolkersdorfer, Ch. (1993): Uranbergbau der ehemaligen SDAG Wismut, Clausthaler Aktivitäten bei Problemlösungen. – Mitteilungsblatt der TU Clausthal, 75: 59—61, 4 fig.; Clausthal.
- Wolkersdorfer, Ch. (1993): Aktuelle Probleme der Wehrgeologie. – N. dt. geol. Ges., 50: 146—149, 2 fig.; Hannover.
- Wolkersdorfer, Ch. (1994): Rubus chamaemorus (Multebeere) als Zeigerpflanze am Sæterfjell (Nordland/Norwegen). – Aufschluss, 45: 82—86, 2 fig., 2 tab.; Heidelberg.
- *Wolkersdorfer, Ch. (1995): Die Flutung des ehemaligen Uranbergwerks Niederschlema/Alberoda der SDAG Wismut. – Z. geol. Wiss., 23 (5/6): 795—808, 4 fig., 6 tab.; Berlin.
- *Wolkersdorfer, Ch. (1996): Hydrogeochemical investigations of an abandoned uranium mine in the Erzgebirge/Germany. – Appl. Geochem., 11: 237—241, 4 fig., 2 tab.; Oxford.
- Wolkersdorfer, Ch. (1996): Hydrogeochemische Verhältnisse im Flutungswasser eines Uranbergwerks – Die Lagerstätte Niederschlema/Alberoda. – Clausthaler Geowissenschaftliche Dissertationen, 50: 1—216, 131 fig., 61 tab.; Clausthal.
- *Wolkersdorfer, Ch. (2001): Tracer Tests in Flooded Underground Mines. – In: Seiler, K.-P. & Wohnlich, S.: New Approches Characterizing Groundwater Flow 1. – S. 229—233, 4 fig., 3 tab.; Rotterdam (Balkema).
- *Wolkersdorfer, Ch. (2002): Mine water tracing. – Geological Society Special Publication, 198: 47—61, 5 fig., 6 tab.; London.
- *Wolkersdorfer, Ch. (2002): Rare Earth Elements (REEs) as Natural Tracers in Mine Waters. – In: Merkel, B., Planer-Friedrich, B. & Wolkersdorfer, Ch.: Uranium in the Aquatic Environment. – S. 967—974, 2 fig., 1 tab.; Heidelberg (Springer).
- Wolkersdorfer, Ch. (2003): Ammonshorn und Ehrwaldit – Geologische Verhältnise um Ehrwald; Gestein aus den Tiefen der Erde – Der Ehrwaldit; Mit Erztrog und Grubenhunt – Ehrwalder Bergknappen schürfen nach Erzen. – In: Haudek, O. & Richter, P.: Ehrwald – Das Zugspitzdorf. – S. 25—28; Ehrwald (Eigenverlag Gemeinde Ehrwald).
- *Wolkersdorfer, Ch. (2004): Mine Water Literature in ISI's Science Citation Index Expanded™. – Mine Water and the Environment, 23 (2): 96—99, 3 fig., 3. tab.; Berlin.
- Wolkersdorfer, Ch., Blume, C. & Weber, C. (2003): Trace Elements in the Waters of Troy. – Wissenschaftliche Mitteilungen, 24: 91—95, 4 fig.; Freiberg.

- *Wolkersdorfer, Ch., Feldtner, N. & Trebušak, I. (2002): Mine Water Tracing – A Tool for Assessing Flow Paths in Flooded Underground Mines. – Mine Water and the Environment, 21 (1): 7—14, 3 fig., 3 tab.; Berlin.
- *Wolkersdorfer, Ch. & Göbel, J. (2004): Hydrogeologie der Troianischen Landschaft – Eine Bestandsaufnahme. – Studia Troica, 14: 157—167, 9 fig., 1 tab.; Mainz.
- *Wolkersdorfer, Ch., Göbel, J., Blume, C. & Weber, C. (2004): Hydrogeologische Probenahmestellen in der Troianischen Landschaft. – Studia Troica, 14: 169—200, 19 fig., 2 tab.; Mainz.
- Wolkersdorfer, Ch. & Hasche, A. (2001): Tracer Test in the abandoned Fluorspar Mine Straßberg/Harz Mountains, Germany. – Wissenschaftliche Mitteilungen, 16: 57—67, 5 fig., 5 tab.; Freiberg.
- Wolkersdorfer, Ch. & Hasche, A. (2004): Tracer Investigations in flooded mines – The Straßberg/Harz Multitracer Test: Conference Papers 35. – S. 45—56, 5 fig., 5 tab.; Wien (Umweltbundesamt).
- Wolkersdorfer, Ch., Hasche, A. & Göbel, J. (2003): ERMITE – Grubenwasser in der Europäischen Union. – In: Sroka, A., Löbel, K.-H., Klapperich, H., Tondera, D., Meier, G. & Busch, W.: 3. Altbergbau Kolloquium. – S. 376—381, 1 fig., 1 tab.; Essen (Glückauf).
- Wolkersdorfer, Ch., Hasche, A., Unger, K. & Wackwitz, T. (2002): Tracer Techniken im Bergbau – Georgi-Unterbau bei Brixlegg/Tirol. – Wissenschaftliche Mitteilungen, 19: 37—43, 4 fig., 1 tab.; Freiberg/Sachsen.
- *Wolkersdorfer, Ch. & Thiem, G. (1999): Ground Water Withdrawal and Land Subsidence in Northeastern Saxony (Germany). – Mine Water and the Environment, 18 (1): 81—92, 3 fig., 4 tab.; Lakewood, CO.
- *Wolkersdorfer, Ch., Trebušak, I. & Feldtner, N. (1997): Development of a Tracer Test in a flooded Uranium Mine using Lycopodium clavatum. – In: Kranjc, A.: Tracer Hydrology 97. – 377—385, 4 fig., 2 tab.; Rotterdam (Balkema).
- *Wolkersdorfer, Ch. & Wackwitz, T. (2004): Antimony Anomalies around abandoned Silver Mines in Tyrol/Austria. – In: Younger, P.: Proceedings International Mine Water Association Symposium. – S. 1—10, 4 fig., 1 tab.; Heidelberg (Springer).
- *Wolkersdorfer, Ch. & Younger, P. L. (2002): Passive Grubenwassereinigung als Alternative zu aktiven Systemen. – Grundwasser, 7 (2): 67—77, 7 fig., 2 tab.; Heidelberg.
- *Younger, P., Wolkersdorfer, Ch. & ERMITE Consortium (2004): Mining Impacts on the Fresh Water Environment: Technical and Managerial Guidelines for Catchment-Focused Remediation. – Mine Water and the Environment, Suppl. Issue 1: 2—80, 28 fig., 6 tab.; Berlin.

Cape Breton Explorations Ltd.

292 Charlotte Street, Suite 101, P.O. Box 244, Stn. A, Sydney, N.S. B1P 6H1
Tel: (902) 539-0147 • **Fax:** (902) 539-4143

BIO: Luciano Lisi

Luciano is President & CFO of Cape Breton Explorations Ltd., a renewable energy company based in Cape Breton , NS, focusing on innovative applications for wind energy, hydro, geothermal , biomass, tidal/wave action and coal bed methane.

The company is currently undergoing environmental assessment of the 250 MW Lake Uist Wind/Hydro Pumped Storage Project , a Merchant Generating Facility.

" I believe in the enormous potential of Renewable Energy and its economic, social and environmental impact."

With Christine Kavanagh and 2 other partners Luciano completed the Glace Bay Lingan Wind Farm with 17.3 MW of installed capacity composed of 7 Enercon E 70 and 2 Enercon E48.

Luciano's motto: "we only develop what we can deliver". Fundamental to that philosophy is the ability to arrange financing and to conceive and execute the projects we develop, hands on.

Luciano Lisi, CFO
Cape Breton Explorations Ltd.
292 Charlotte Street, suite 101
P.O. Box 244, Station A
Sydney, NS, B1P 6H1
Tel:902 539 0147
Fax:902 539 4143
Email:luciano@cbexplorations.com

Cape Breton Explorations Ltd.
292 Charlotte Street, Suite 101, P.O. Box 244, Stn. A, Sydney, N.S. B1P 6H1
Tel: (902) 539-0147 • **Fax:** (902) 539-4143

BIO: Christine Kavanagh

Christine is President of New Aberdeen Garden Townhouses Inc. and Vice-President of Cape Breton Explorations Ltd., a renewable energy company based in Cape Breton , NS, focusing on innovative applications for wind energy, hydro, geothermal , biomass, tidal/wave action and coal bed methane.

The company is currently undergoing environmental assessment of the 250 MW Lake Uist Wind/Hydro Pumped Storage Project , a Merchant Generating Facility as well as being in advanced stages of development of a 60 MW Biomass facility in Cape Breton.

With Luciano Lisi and 2 other partners Christine completed the Glace Bay Lingan Wind Farm with 17.3 MW of installed capacity composed of 7 Enercon E 70 and 2 Enercon E48.

Christine conceived the idea of the 16 Unit complex being built in Glace Bay as New Aberdeen Garden Townhouses Inc as an affordable, sustainable, environmentally friendly and community oriented rental building.

Christine Kavanagh, VP
Cape Breton Explorations Ltd.
292 Charlotte Street, suite 101
P.O. Box 244, Station A
Sydney, NS, B1P 6H1
Tel:902 539 0147
Fax:902 539 4143
Email:luciano@cbexplorations.com