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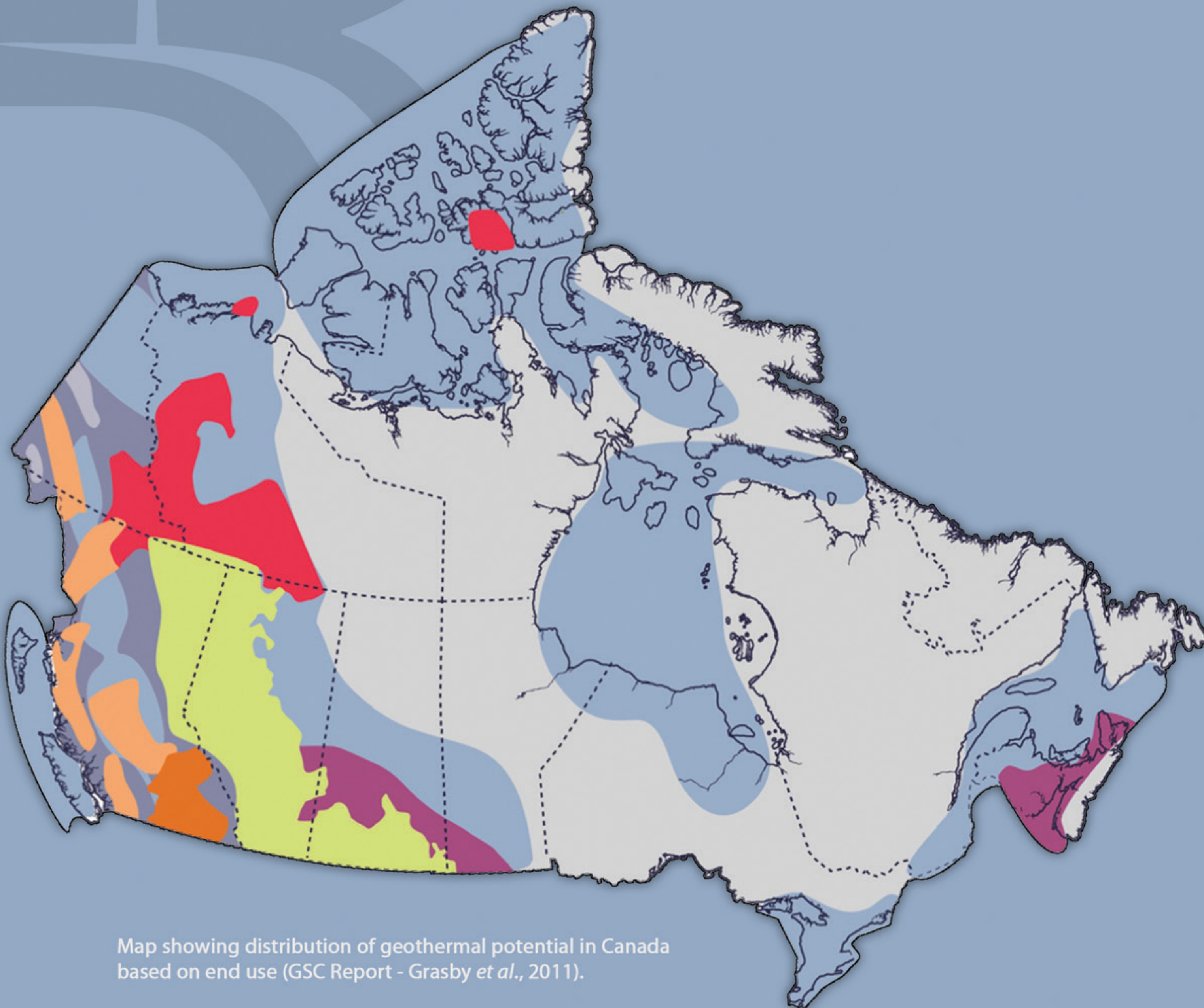
CanGRC Review

Issue 1 • Summer 2011



Map showing distribution of geothermal potential in Canada based on end use (GSC Report - Grasby *et al.*, 2011).

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CanGRC Review

Official Launch of the Canadian Geothermal Research Council

Written by Ryan Libbey, Yuliana Proenza and Lena Patsa
CanGRC Co-Founders

Geothermal technologies are clean and reliable energy sources that take advantage of the thermal properties of the Earth's subsurface for direct use heating and cooling applications and electricity generation. Canada has already begun to utilize these technologies for heating and cooling purposes; however, it remains one of the only countries on the Pacific Rim to not produce electricity from geothermal resources. Studies released by the Geological Survey of Canada show these untapped subterranean resources to be vast, and new reservoir technologies may make geothermal electricity generation feasible nation-wide. Needless to say, geothermal research in Canada is a pertinent and stimulating field of study.

The Canadian Geothermal Research Council (CanGRC) is a voluntarily-run organization dedicated to serving Canada's geothermal research community. It does not exist as a government lobby group, nor is it intended to represent a unified voice of the research community. Rather, CanGRC exists to raise awareness about geothermal research in Canada, to showcase Canadian geothermal research and to elevate communication within the research community.

CanGRC is a recent initiative by 3 graduate students from across the country - Ryan Libbey (McGill University), Yuliana Proenza (University of British Columbia) and Lena Patsa (University of British Columbia). CanGRC operations are guided by an esteemed Board of Directors, which includes geothermal scientists from academic, government and industry positions. Currently serving on this Board is Dr. Grant Ferguson (St. Francis Xavier University), Dr. Catherine Hickson (Alterra Power Corp.), Mr. Craig Dunn (Borealis Geopower) and Dr. Steve Grasby (Geological Survey of Canada / Natural Resources Canada / University of Calgary).

Membership to CanGRC is completely free and includes a subscription to this bi-annual newsletter. We encourage everyone interested in geothermal research to join. If you haven't already done so, simply head to our website at www.cangrc.ca/members.html and fill out the form.

We greatly appreciate your interest and feedback, and hope that you enjoy the premier issue of the *CanGRC Review*.

Best wishes,
The CanGRC Team

Chief Editor. Ryan Libbey
Content Managers. Yuliana Proenza, Lena Patsa and Ryan Libbey
Graphic Design. Ryan Libbey

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To contribute an article to the CanGRC Review, please email your submission to info@cangrc.ca. Submissions should be in .doc format. Please send all related images as separate high-quality attachments.

All are welcome and encouraged to submit. It is the intention of this publication to showcase members from a range of sectors and disciplines. Student submissions are welcome.

Whatever Happened to Geothermal Energy?

Original Article[1] by Dr. Allan Woodbury
Synopsis by Yuliana Proenza

Dr. Allan Woodbury supplies a great article on his website[2] that characterizes the advantages and challenges for geothermal energy in Canada within the changing landscape of conventional and renewable power generation sources. The following is only a brief synopsis of the original content.

Canada has traditionally focused on relatively low-temperature geothermal resources referred to as geo-exchange systems[3] and this industry has experienced extensive market growth. However, a substantial high-temperature geothermal resource exists in Canada that has not been developed and will play an important role as part of Canada's sustainable energy portfolio, especially given its ability to provide reliable base load power. There is 10 GW of globally installed capacity with the United States producing the greatest amount at 3 GW installed capacity[4]. The global geothermal industry is investigating the use of hot dry rock as Enhanced Geothermal Systems (EGS)[5] within 5 km of the Earth's surface; global resource estimates including EGS are in excess of the conventional geothermal resource of 40 million MW[6].

The estimate of high-temperature resources in Canada is based on various geographical and geological sources that are primarily located in Western Canada (Figure 1). A 2011 report by Grasby *et al.*[7] investigates the resources present in the western Canadian Cordillera, as well as the sedimentary basins and Canadian Shield of central and eastern Canada and finds that the in-place resource exceeds Canada's current electricity consumption. The report summarizes heat flow in shallow and deep Canadian rocks, geothermal resources in mining environments, the future of EGS and the relevance of understanding the regional stress regime to geothermal development. Environmental impacts, cost and market risk analysis are also discussed and 10 geoscience research priorities are identified and recommended. The need for further characterization of the Canadian geothermal resource is demonstrated but it is clear that a significant resource exists.

The economics of geothermal resources are dependent on the depth of the resource. Drilling is a large part of development, and drilling costs are high when compared to lower upfront costs of other renewable power applications such as wind turbines and solar panels. However, geoscience data is available; such as heat flow values, sub-surface temperatures, hydrogeology and thermal properties. This information can be used to predict temperatures at depth and later confirmed by expensive drilling with increased confidence. For example, cost estimates by BC Hydro for various electricity generation plants places conventional geothermal power levelized costs at about \$71-200/MWh_e[9], completely competitive with the cost ranges of wind, biomass, and large hydro as energy sources (\$77-200/MWh_e). Conversely, the investment costs for EGS range between \$2-4Mil/MW_e (Majorowicz & Grasby, 2010[9]; IGA Geothermal Roadmap, 2011[4]).

There are major challenges ahead for geothermal energy in Canada but there is evidence that it is competitive when it comes to environmental concerns, resource sustainability and cost estimates. Further geothermal energy development of low- to high- temperature resources is dependent on a greater understanding of the thermal regime and groundwater flow in the subsurface. Important assessments are required in the design of individual geothermal systems and associated hydrogeological investigations to ensure environmental compliance and sustainability. Physical barriers are a major challenge that affects the exploration and development of high-temperature resources. In some areas very little subsurface data is available, requiring additional funding to gather enough reliable data for accurate estimates and analyses. Government policies and actions are also required to support development. The continued collection of necessary geoscience data must be combined with government incentives in place to support the companies and organizations that will be risking exploration and development dollars in Canada.

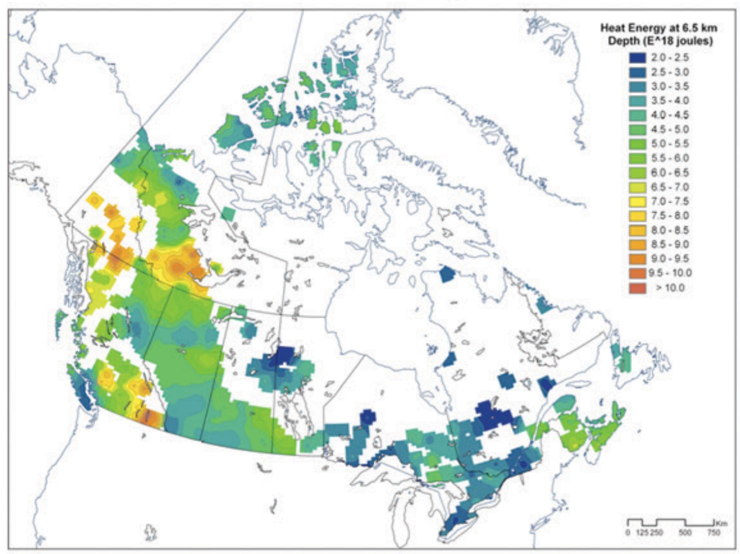

Figure 1. A map of the geothermal resource in Canada[7].

[1] Dr. Allan Woodbury, P.Eng. is Professor of Civil Engineering, University of Manitoba.
[2] Woodbury, A., 2011. Whatever happened to geothermal energy? http://home.cc.umanitoba.ca/~woodbur/commentary.pdf, accessed August 2011
[3] Canadian Geo-exchange Coalition, http://www.geo-exchange.ca, accessed August 2011
[4] IGA, 2011. Technology Roadmap: Geothermal Heat & Power. www.iea.org/papers/2011/Geothermal_Roadmap.pdf, accessed August 2011
[5] Tester, 2006, The future of Geothermal Energy, MIT, ISBN: 0-615-13438-6
[6] Rybach, L. 2003. Geothermal energy: sustainability and the environment. Geothermics 32: 463-470.
[7] Grasby et al. 2011. Geothermal energy resource potential of Canada, Geological Survey of Canada, Open File 6914, 2011; 322 pages http://www.geopub.nrcan.gc.ca/moreinfo_e.php?id=288745, accessed August 2011
[8] BC Hydro Integrated Resource Plan Consultation Workbook, 2011. http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/iep_ltap/2011q1/bc_hydro_irp_consultation.Par.0001.File.BC-Hydro-IRP-Consultation-Workbook-February-24-2011.pdf, accessed August 2011
[9] Majorowicz, J. and S.E. Grasby, 2010. High potential regions for enhanced geothermal in Canada, Nat. Resour. Res. , 19(3), 177-188.

CanGRCReview

Improving Tools and Methods for GLHE Design

Written by Dr. James Craig, University of Waterloo
Simon R. Haslam, University of Waterloo
Richard B. Simms, University of Waterloo
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NextEnergy™ GEOTHERMAL FOR YOUR HOME

UNIVERSITY OF WATERLOO

Ground loop heat exchangers (GLHEs) utilize low-grade geothermal energy to provide efficient heating and cooling for buildings. One impediment to the growth of the GLHE industry is the large land area needed for horizontal GLHE systems, which are significantly cheaper than vertical borehole systems. Currently, GLHEs are intentionally overdesigned to account for the large amount of uncertainty in our understanding of subsurface energy processes. In partnership with NextEnergy Inc., and supported by Ontario Centres of Excellence, current research at the University of Waterloo is aimed at improving our understanding of the heat transfer mechanisms in the subsurface and the interactions between soils and the ground loop. Knowledge gained will ideally allow GLHE installers to safely design their systems more conservatively, decreasing the cost of installation and the amount of land area and materials required, increasing feasibility for the average home.

Figure 1. GLHE installation at test site in Elora, ON.

The research involves two major components: monitoring of a horizontal GLHE and development and application of improved GLHE modelling tools. A couple in Elora, ON, have generously provided access to their recently installed GLHE, which was specially designed with multiple loop configurations for monitoring and data collection. Several thermistor arrays were installed to monitor temperature variations in areas of interest along the ground loop and in the adjacent subsurface. The furnace was equipped with power and temperature monitoring devices. Current transducers were installed to monitor the power consumption of the various components of the heat exchanger and thermistors were installed to observe the incoming and outgoing loop and air temperatures. Analysis of the streaming data is ongoing.

Supplementing the monitoring work, a 3D model using the evolutionary extended finite element method (XFEM) is being developed to simulate the interactions between horizontal ground loops and the subsurface. The specialized model is capable of simulating complex systems with multiple pipes and trenches in various orientations, without the computational overhead of standard heat transfer models. The primary model output is the fluid temperature distribution within the ground loop, which determines the efficiency of the GLHE system. This model will be used to conduct a range of experiments intended to determine the effects of both loop configuration and soil properties/heterogeneity on system performance and efficiency.

Figure 2. UW & NextEnergy GLHE research team.

Concurrently, improved analytical models are being developed as design tools for horizontal GLHE installers. Existing design guidelines are being reviewed in light of the information gained from these numerical, analytical, and field investigations.

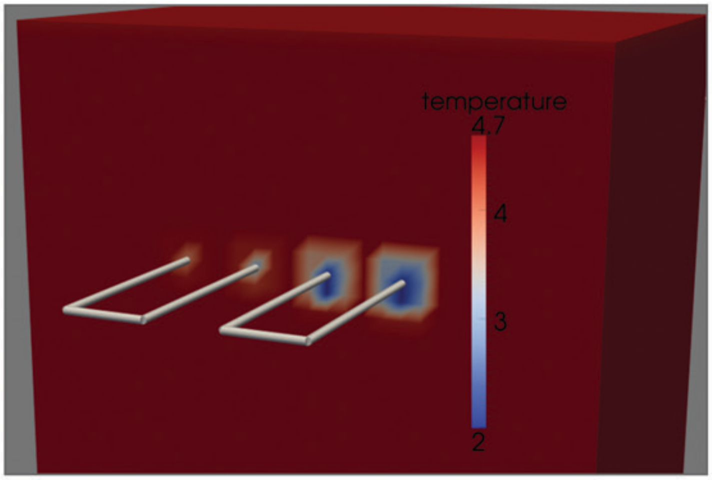

Figure 3. Example XFEM model output.

The knowledge gained from this research is hoped to advance the science of low-grade geothermal energy and the GLHE industry by providing insight into design methods and improved tools with which GLHE systems can be analyzed.

New research on thermal conductivity testing and a visit from Professor Hikari Fujii at ÉTS

Written by Dr. Jasmin Raymond

The École de Technologie Supérieure (ÉTS - School of Superior Technologies) in Montréal will start a new research program on in-situ thermal conductivity testing for geothermal heat pumps next September. Research will be carried out by Dr. Jasmin Raymond as a postdoctoral fellow under the supervision of Professor Louis Lamarche. Multidisciplinary research will combine hydrogeology and mechanical engineering.

One of our first public activities will be the visit of Professor Hikari Fujii form Kyushu University, Japan, during the 20th of October. Professor Fujii is a leading researcher on geothermal heat pumps known for his innovative work on in-situ thermal conductivity tests. During his visit at ÉTS in Montréal, Professor Fujii and one of his grad students will present a talk. More information about the subject and time of the talks will be available shortly. People interested to attend can contact Jasmin Raymond at jraymond@hydro-geo.net for more information.

The Canadian Geothermal Energy Association (CanGEA) congratulates the Canadian research community on the establishment of CanGRC

Written by Alexander Richter, Director of CanGEA
www.cangea.ca

The Canadian Geothermal Energy Association (CanGEA), has over the last years been the collective voice of Canada's geothermal energy industry. In our activities we represent the interests of our member companies with the primary goal of unlocking Canada's tremendous geothermal energy potential.

With the strong background in natural resources, mining and oil & gas, Canadian firms have been on the forefront of geothermal development outside of Canada. At the same time there is a strong research community in Canada. We welcome the foundation of the Canadian Geothermal Research Council, as a research organization that provides a voice for the geothermal research community in Canada. We are particularly pleased that our organizations agree in the need for collaboration of all players in the geothermal energy sector in Canada, be it on the industry side or within the research community. Only a unified voice will allow us to effectively promote geothermal energy in Canada and get the necessary political support. In a recently published report by the Geological Survey of Canada, Canada is described to have "enormous geothermal resource potential". To help in the development of those resources to provide clean and sustainable geothermal base-load power to Canadians, we need to work together.

With the increasing development of geothermal projects all over the world, there will be a shortage of qualified personal to drive this development. Therefore education, but also research on new technologies that help the industry to drive is in the interest of the Canadian geothermal energy industry that CanGEA represents. We need the research community to be competitive in the growing geothermal market globally. We congratulate the founders of the Canadian Geothermal Research Council on the establishment of the organization and wish all the best with its ambitious goals. We will be glad to support those efforts where we can.

Alexander Richter on behalf of the Canadian Geothermal Energy Association (CanGEA)

CanGEA
CANADIAN GEOTHERMAL ENERGY ASSOCIATION

CanGRC Review

The High-Temperature Geothermal Energy Industry in Canada

Written by Mr. Craig Dunn
Chief Geologist, Borealis GeoPower Inc.
CanGRC Board of Directors
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Geothermal (or earth heat) energy is a clean, renewable source of both power and heat that has already been developed globally. It is proven technology that provides baseload (24 hours a day, 365 days a year) power, has low to no emissions and one of the smallest environmental footprints of any power supply. The recent release of the Geological Survey of Canada's "Geothermal Energy Resource Potential in Canada" demonstrates that geothermal energy can be a practical energy solution for an entire generation of Canadians.

So why is Canada currently not producing a single megawatt of power from geothermal?

There have been a number of Canadian individuals and companies that have working on geothermal energy development internationally for decades and many of us involved in geothermal research are well aware of past developments at Mt. Meager, BC. Of note: Ram Power, who currently hold the lease for South Meager, are currently not moving forward with development of the project. However, for the first time in years we can finally say that there are actually a number of innovative projects that are currently moving forward to bring Canada its first power geothermal power production.

Figure 1. Ainsworth Hotsprings, BC (**src:** www.travelinbc.com).

As the only jurisdiction in Canada with any geothermal regulation for power development, a history of exploration for geothermal resources and many active hotsprings, BC is the obvious place to look for geothermal projects to develop. BC has been the site of many development plans in the past and recent geothermal exploration permits have continued to drive interest to geothermal.

In October 2010, Borealis acquired three geothermal exploration permits for the area of Canoe Reach, near Valemount British Columbia. The project is a notional ~10MWe standard hydrothermal development project and Borealis is working with local first nations and local community to develop the geothermal resource. The expected geothermal power facility is close to existing power infrastructure and could provide heat opportunities for the community as well.

Most recently in June 2011, the province of British Columbia announced a Crown Geothermal Resources Notice of Public Tender for three geothermal permits in the Upper Lillooet River area Northwest of Pemberton in the West of BC. On July 26th, BC Ministry of Energy and Mining accepted the offer for the three licenses sold and set a record price for geothermal energy. The licenses sold for $ 229,108.10, for a total of 8056 acres near Lilloet, British Columbia. Two of the permits were acquired from Salal Geothermal Inc. and the other from Ontario Inc. 214 979.

The geothermal resource potential does not end at the BC border - a number of other projects across Canada are also in development.

In Ft. Liard, NWT, Borealis is working with the Acho Dene Koe First Nations and multiple government organizations to develop the geothermal energy resource. This "off the grid" smaller-scale geothermal energy project would entail bringing cost effective electricity generation and direct heat opportunities to a native community that is currently producing its' power from diesel generation. This small scale project (<1MWe) would be the first of its kind as a source of baseload renewable power in a remote community and provide a model for other northern and First Nations communities with available geothermal resources. The project was approved by Natural Resource Canada's Clean Energy Fund: (Renewable Energy and Clean Energy Systems Demonstration Projects Funding) for $10-20 million in project funding.

In Swan Hills, Alberta, Borealis Geopower and multiple project partners are working to develop a co-produced fluids project that will use low grade oilfield waste water (<100C) and binary turbine technology to produce 1 MW of geothermal energy at an existing oilfield production facility. This innovative project was approved for a grant of up to $2,600,000 provided by the Alberta Energy Research Institute (AERI), (now Innovate Alberta) through their Clean Air and Climate Change: Technology and Innovation Initiative. The power production plant will be used as an alternative or supplementary source of electricity at the oilfield facilities.

In the Yukon, Yukon Energy has already started research into finding geothermal resources significant enough to produce a substantial amount of its electricity needs. With some financial assistance from the Yukon Cold Climate Innovation Centre, they

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have begun remote sensing satellite imagery and infrared thermal sensors to locate geothermal hotspots. The challenge has been locating quality resources near existing transmission system. The research has uncovered encouraging results in several spots, including the Jarvis Creek area near Haines Junction and a small drilling program at this location was completed in 2010. Yukon Energy is expecting to continue exploration and development for geothermal resources in the future.

DEEP (Deep Earth Energy Production) is moving forward with the development of a geothermal energy project in Southeast Saskatchewan in the Williston Basin and have a goal of power production by 2013. They have completed a Lease of Space agreement with the Saskatchewan Ministry of Energy and Resources providing an initial exclusive location for geothermal power development. DEEP were also successful in being accepted into SaskPower's Green Options Partners Program as a less than 5 MWe project.

As we move further east, there have also been a number of groups that have begun researching the opportunity for geothermal as power source including Manitoba Hydro and Quebec Hydro. With more projects moving forward, this will help to create further exposure for new geothermal development and industry support across Canada.

In the past geothermal energy development for electricity production has long been focused on larger scale (>20MW) development and production opportunities. However, many of these innovative geothermal projects are on a smaller scale (<10MW) and act as distributed energy generation, this is a strong fit with initiatives for clean energy programs and community development programs in Canada. With multiple power projects in development, this is an exciting time to be involved in geothermal energy research.

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