



Northern Alberta Geothermal Potential Mapping Project – Final Report

February, 2019





Background:

On March 28 and March 30, 2017, the Northern Alberta Development Council (NADC) hosted the Energizing the North Seminars in Athabasca and Peace River, respectively. The focus of the Seminars was to present opportunities for economic diversification and greater energy self-sufficiency in northern communities. The conference raised awareness of the potential of renewable energy sources such as geothermal for northern communities.

With support from the NADC, the Alberta Community & Co-operatives Association (ACCA) prepared a Community Energy Cooperative Toolkit that defined renewable community energy, highlighted several renewable energy funding programs, defined the types of cooperatives, provided the four developmental stages of community energy cooperatives, and offered community energy case studies.

Resulting from the outcomes of this partnership, in December 2017 the NADC provided the ACCA grant funding to conduct a feasibility study on geothermal energy in northern Alberta.

ACCA contracted Terrapin Geothermics Inc. to conduct a high-level geothermal resource evaluation for a representative sampling of forty two northern Alberta communities over a five month period.

The focus of this project was to create location-specific research reports that provided high-level technical overviews of geothermal resource potential, considering both the potential temperatures to be found and unique geological considerations in the targeted communities.

One of the primary objectives was to provide all sub-regions with guidance as to the comparative quality of their geothermal resource, and recommend future research focus areas should they be keen to develop the geothermal resource in their region.

Purpose of the Report

Alberta is in a unique position to achieve long-term success in the geothermal industry due to the industry understanding of down-hole drilling activities, sub-surface safety, and access to skilled labour. Northern Alberta possesses a significant portion of the deep (below 2,500 metre) wells in the province, making it ideal for geothermal development.

Geothermal interest in the province has increased over the last few years for several reasons including: improved available data; advances in technology; recognition of the



possible opportunity to re-use of inactive oil and gas wells; and the province's transition to a lower carbon future.

The Alberta government is developing a geothermal policy and has recently conducted engagement sessions with stakeholders. Currently, projects are being reviewed on a case-by-case basis.

Shallow geothermal, also known as geo-exchange, currently exists in Alberta on a small scale, such as for household use, but not for large-scale commercial application.

The research in this report identifies types of viable projects (power production, direct use, or direct heat) while also encouraging the onset of a geothermal market in northern Alberta by providing accurate data to potential developers.

Thirty one of the evaluated areas demonstrated suitable temperatures and basic geological factors to support further investigation into direct use opportunities and twelve areas were identified as containing suitable temperatures and geological factors for power generation.

This final report, including individual assessments for each of the studied communities, will be made available online to be used by planners, economic development officers, municipalities, industry, and community groups interested in the geothermal potential in their regions.

What is Geothermal Energy

Geothermal energy refers to the heat available from within the earth and is classified as a renewable energy resource. Based on Alberta's sub-surface geology, the highest quality geothermal resources in the province are in the northern and western regions, making the geothermal industry the only source of renewable energy that is better in the northern part of the province than in the south.

Geothermal energy developments can be used for a variety of different things depending on the quality of the resource. The hotter the temperature available, the greater the number of possibilities exist for using this resource. In general, the projects you can develop in this industry break down into a few main categories:

1. **Geo-Exchange:** A few feet beneath the surface, the earth's temperature remains fairly constant, about 4-6°C year-round in Canada. Geo-exchange takes advantage of this constant temperature to provide extremely efficient heating and cooling for houses, commercial buildings or light industrial facilities. In winter, a water solution circulating through pipes buried in the ground absorbs heat from the earth and carries it into the home or building. The Geo-exchange system inside the home uses a heat pump to concentrate the earth's thermal energy and then to transfer it to air circulated through



standard ductwork to fill the interior space with warmth. In the summer, the process is reversed: heat is extracted from the air in the house and transferred through the heat pump to the ground loop piping. (Taken from Canadian GeoExchange Coalition). Geo-exchange projects are typically focused on individual houses or commercial buildings with costs in the thousands of dollars range. Geo-exchange projects are not extracting geothermal energy from the earth; they are using the earth as a heat battery.

2. Direct Heat Use. Even if a geothermal resource is below the threshold for power generation (90°C), there is a significant opportunity to use the hot water as a direct heating source, often displacing natural gas being used for heating. Hundreds of examples of direct heat use projects exist across the world including district heating systems, industrial facility heating projects, greenhouse heating, snow melting, pool heating, crop drying, timber drying and many more. The higher the temperature, the more options exist to develop a direct heat use project.


3. Electricity Generation. Deep geothermal resources with temperatures above 90°C can be used to produce electricity. Electricity generation projects are highly valuable developments to pursue as the power generated can be connected to Alberta's electricity grid to be sold anywhere in the province. Geothermal electricity projects require drilling relatively deep (1,500 metres – 4,500 metres) to extract hot water that is trapped sub-surface. This hot water is called a geo-fluid and is almost exclusively salt water in sub-surface aquifers. The higher the temperature of the geo-fluid, the better the economics of a power generation project will be.

The region specific report has analyzed each region in northern Alberta's geothermal resource with a focus on temperature mapping in order to frame which category of projects would be worth further exploration.

This report is focused exclusively on temperature mapping and is a desktop study that uses pre-existing data available from existing energy developments in the province to estimate the quality, quantity and location of the best geothermal resource in each region.

Attachments

- Mapping Project Final Report

	Geothermal Potential Mapping	Doc #	TGI-2018-ACCA-001
	Alberta Community & Co-operative Association	Date	2018-09-25
		Rev	C

Terrapin Geothermics Inc.

Northern Alberta Geothermal Potential Mapping - Final Report

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1.0 Executive Summary

A key issue for communities in determining their renewable energy development opportunities is to have access to comprehensive, up-to-date, and geographically organized information on resources in their locality. When assessing the geothermal resource potential of Alberta, there are a number of considerations that need to be investigated: the depth of the resource, resource temperature, specific geological characteristics including the porosity of rock or sediment, and flow rate of any geothermal fluids. Knowledge of the temperature at depth, the depths and thicknesses of various geological formations and the likelihood of these formations containing large amounts of accessible fluids can substantially de-risk expensive exploratory activities. Terrapin was contracted to conduct a high-level geothermal resource evaluation for a representative sampling of northern Alberta communities. The focus of this project was to create location-specific research reports that provided a high-level technical overview of the geothermal resource potential of the studied areas, considering both the potential temperatures to be found and unique geological considerations in the targeted communities. One of the primary objectives in conducting this work was to provide all sub-regions with guidance as to the comparative quality of their geothermal resource, and recommended future research focus areas should they be keen to develop the geothermal resource in their region.

Terrapin conducted this work over a 5-month period through Winter and Spring of 2018. Over the course of this work, it has been identified that all 42 studied northern communities demonstrate the potential for geo-exchange activities. 31 areas demonstrated suitable temperatures and basic geological factors to support further investigation into direct use opportunities. Terrapin identified 12 areas as containing suitable temperatures and geological factors for power generation (see page 5 of this summary).

Terrapin is happy to present the findings of these studies to any community that is interested/at any events where studied municipalities will be present. Determining whether to pursue a geothermal project is dependent on the ambition/ability/capital availability of each distinct community.

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2.0 Introduction and Scope

Having previously conducted geothermal resource assessments for two northern Alberta municipalities, Terrapin was intrigued by the potential geothermal opportunities within the remainder of northern Alberta. This project would facilitate a high-level understanding of the geothermal resource potential of these territories in order to investigate and evaluate an opportunity for development. Specific project scope was as follows:

1. Define geothermal resources and provide a high-level understanding of geothermal energy uses.
2. Provide a high-level understanding of the specific geothermal resource in a selected group of municipalities.
 - a. This list of communities was restricted to all Counties/Municipal Districts/Regional Municipalities and municipalities with population greater than 1500 people, for which this work had not already been completed.
 - b. Studies were restricted to areas within a 25km diameter circle for Towns and Cities. All other study areas were restricted to 50km diameter circle.
 - c. Communities that met the population threshold but did not contain any data points from which to work were excluded.
3. Recommend future geothermal studies and/or geothermal development opportunities based on the comparative quality of the geothermal resource.
4. Provide technical reports for all identified communities.

3.0 Geothermal Results

Terrapin conducted high-level, desktop studies of a number of northern Alberta municipalities. The detailed technical results and geothermal explainer document have been provided for all mapped areas. Presented below is a chart demonstrating the most promising geothermal applications in each area:



Geothermal Potential Mapping

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Study Area	Geo-exchange	Direct Use	Power Generation
Athabasca County	✓	✓	
Athabasca	✓	✓	
Beaverlodge	✓	✓	
Big Lakes County	✓	✓	✓
Birch Hills County	✓	✓	
Bonnyville	✓		
Clear Hills County	✓	✓	✓
Cold Lake	✓		
County of Northern Lights	✓	✓	✓
County of St. Paul	✓		
Fairview	✓	✓	
Grande Cache	✓	✓	
Grande Prairie	✓	✓	✓
Grimshaw	✓		
High Level	✓		
High Prairie	✓	✓	
Lac La Biche County	✓		
Manning	✓	✓	
M.D. of Bonnyville	✓		
M.D. of Fairview	✓	✓	
M.D. of Lesser Slave River	✓	✓	✓
M.D. of Opportunity	✓	✓	✓
M.D. of Peace	✓	✓	
M.D. of Smoky River	✓	✓	
M.D. of Spirit River	✓	✓	✓
Mackenzie County	✓	✓	
Northern Sunrise County	✓	✓	
Peace River	✓	✓	
Peavine Metis Settlement	✓		
Regional Municipality of Wood Buffalo	✓		
Saddle Hills County	✓	✓	
Saddle Lake #125	✓	✓	
Sexsmith	✓	✓	
Smoky Lake County	✓		
Slave Lake	✓	✓	✓
St. Paul	✓		
Swan Hills	✓	✓	✓
Wabasca (South)	✓	✓	✓
Wabasca #166-166D	✓	✓	
Wembley	✓	✓	
Whitcourt	✓	✓	✓
Woodlands County	✓	✓	✓

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4.0 Conclusion and Future Work

Over the course of this engagement, a number of compelling opportunities presented themselves in some member territories. While the desktop, high-level understanding of the studied municipalities' geothermal potential has been developed to a reasonable point of confidence, additional work will be needed across a few key areas including:

1. Presenting the results of these studies to all studied northern Alberta communities
2. Developing a detailed understanding of the geothermal resource potential in the identified high-opportunity (power-generation and direct-use) areas
3. Establishing an understanding of the development needs and/or wants of studied municipalities
4. Developing an understanding of heat loads and potential offtakes in the northern Alberta regions (i.e. large industrial facilities and/or municipal facilities such as recreation centers)
5. Exploration of additional grant and subsidy opportunities available to geothermal development and applications to relevant programs on behalf of interested municipalities.