

GEOTHERMAL ENERGY AS A POTENTIAL SOLUTION

Geothermal resources exist in Yukon. Some Yukon communities are already tapping into geothermal resources for heat, and the Takhini Hot Springs have been enjoyed by residents and tourists for decades. However, we could also be benefitting from our geothermal resources with the following applications:



Residents enjoy the benefits of local hot springs.

- * Horticulture: Geothermal power could heat greenhouses and provide electricity for artificial lighting to make year-round operation possible.
- * Recreation: Geothermal heat exchangers could be used to heat swimming pools and other indoor recreation facilities.
- * Aquaculture: Geothermal energy could heat water for rearing Arctic grayling, northern pike, and lake trout.
- * Space heating: Geothermal heat could be generated by heat pumps (geo-exchange), direct use, or be derived from geothermal fluid flowing out of a power plant.

Why has geothermal heat not been extensively developed in Yukon? There are a variety of challenges including:



Geothermal drilling, Alaska.

- * Currently, heat-flow data only exist for remote areas of Yukon, where exploration drilling for oil and gas resources has been undertaken. More heat-flow measurements are needed to identify prospective areas that are near communities.
- * A better understanding of deep aquifers is necessary to predict permeability, flow rate, and other factors that influence the accessibility of the resource.
- * A regulatory regime for Yukon is required to grant the tenure which would enable exploration, and govern other aspects of geothermal development and production. In Canada, legislation currently exists only in British Columbia.
- * Geothermal exploration and development are expensive and require significant investment.

In spite of these challenges, the opportunities are exciting, as Yukon is in a region with high geothermal development potential and has a growing demand for energy.



Geothermal Energy Yukon



WHAT IS GEOTHERMAL ENERGY?

Earth's interior contains heat energy (i.e., geothermal energy) that can potentially be harnessed for direct heating or electricity generation. The Earth's crust is naturally heated through the radiogenic decay of elements and the ascent of magma from the mantle. Although heat naturally radiates from depth to surface, local geological conditions in certain areas can lead to anomalously high heat flow and hence, geothermal resources that are within reach. In such regions, wells can be drilled into geothermal reservoirs where hot water and steam trapped in cracks and porous rock can be brought to the surface, allowing us to harness the energy.

Geothermal energy can be used for electricity generation where fluid temperatures are medium to high (generally >150°C); under some conditions, electricity generation is possible with a temperature as low as 80°C. Medium to low-temperature geothermal resources can be used for direct space heating of residences, commercial buildings and greenhouses. At low but constant temperature, shallow geothermal resources can also be tapped by geo-exchange (or heat pumps) to facilitate energy recovery.

Geothermal energy is a clean and renewable source of energy that, if managed properly, is able to provide an energy supply that does not fluctuate with changes in external factors such as wind speed or stream flow.



Geothermal power plant, Nesjavellir, Iceland.

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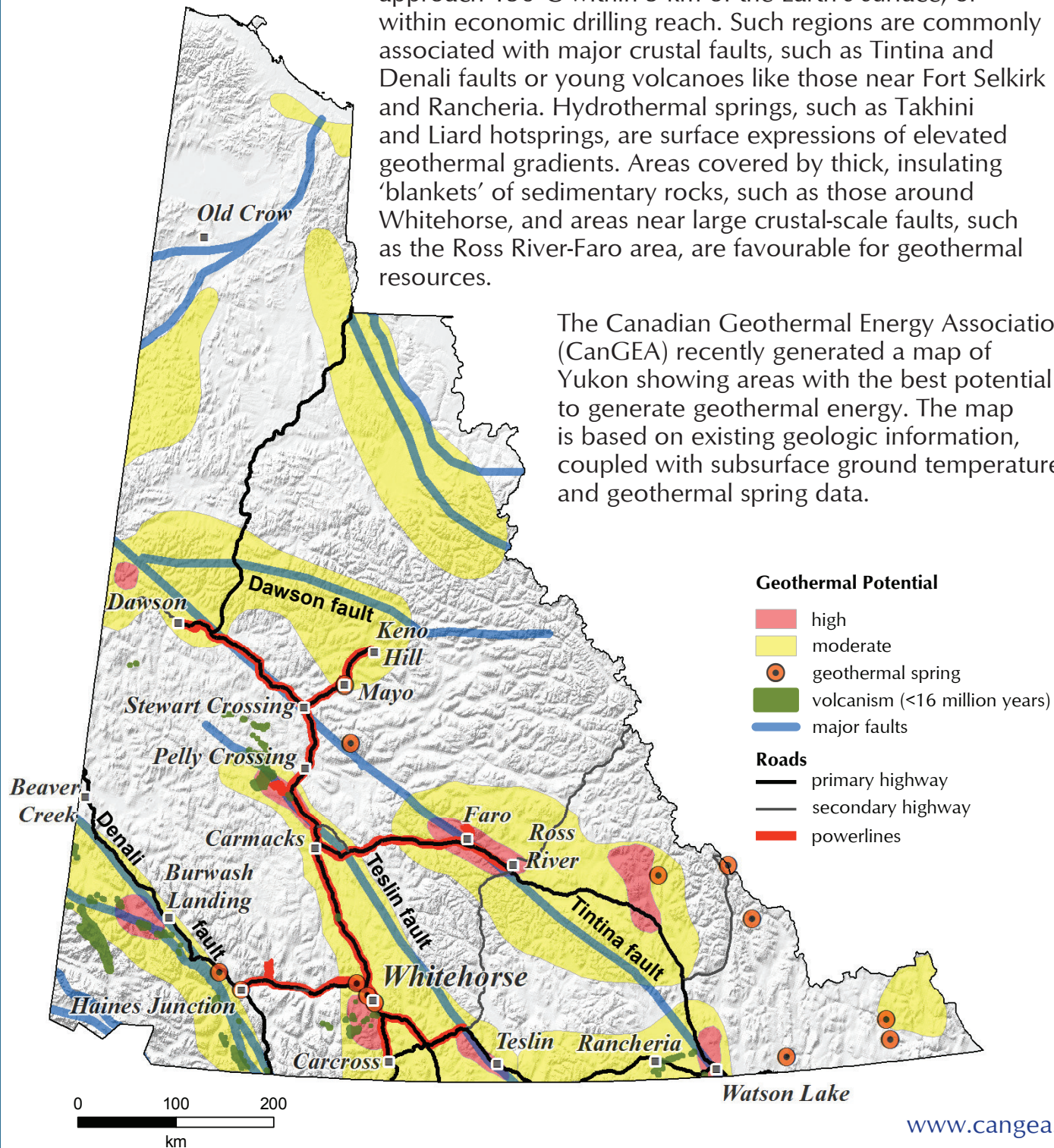
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GEOTHERMAL POTENTIAL IN YUKON

Geothermal gradient is defined as the increase of temperature with increasing depth in the Earth, typically 25°C to 30°C per kilometre. It varies depending on the geological setting. The steepest geothermal gradients (>30° C/km), or regions with highest heat flow, due to heat generation in the crust, are typically found near tectonic plate boundaries. Yukon is situated near the boundary between the North American and Pacific plates, along the Pacific 'Ring of Fire'. It locally has some of the highest heat flow in western Canada at ~105 mW/m² (milliWatt per square metre), or about twice as much as that of the Canadian Shield to the east (~53 mW/m² at Yellowknife).

Areas with medium to high potential for geothermal resources are those where temperature is inferred to approach 150°C within 5 km of the Earth's surface, or within economic drilling reach. Such regions are commonly associated with major crustal faults, such as Tintina and Denali faults or young volcanoes like those near Fort Selkirk and Rancheria. Hydrothermal springs, such as Takhini and Liard hot springs, are surface expressions of elevated geothermal gradients. Areas covered by thick, insulating 'blankets' of sedimentary rocks, such as those around Whitehorse, and areas near large crustal-scale faults, such as the Ross River-Faro area, are favourable for geothermal resources.

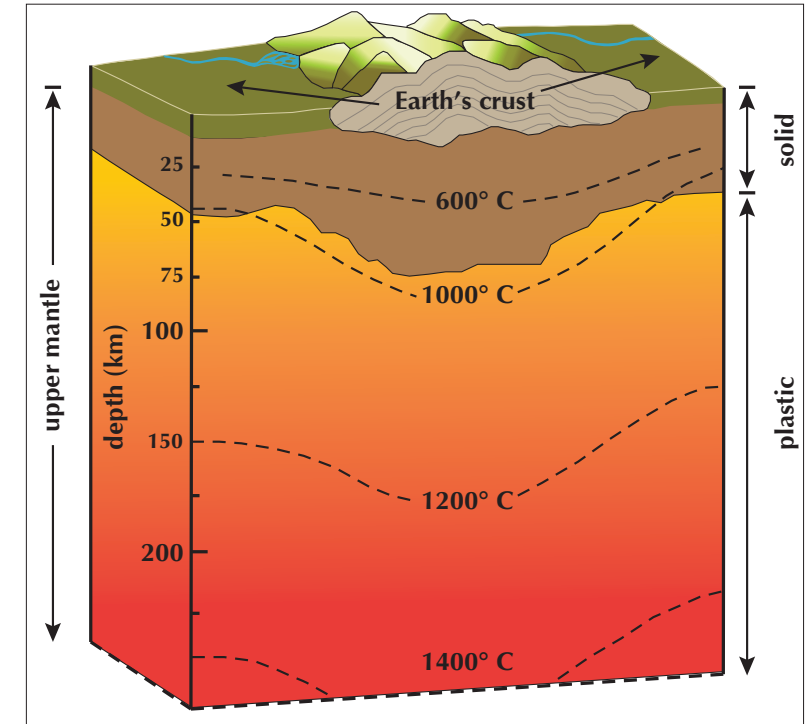
The Canadian Geothermal Energy Association (CanGEA) recently generated a map of Yukon showing areas with the best potential to generate geothermal energy. The map is based on existing geologic information, coupled with subsurface ground temperature and geothermal spring data.



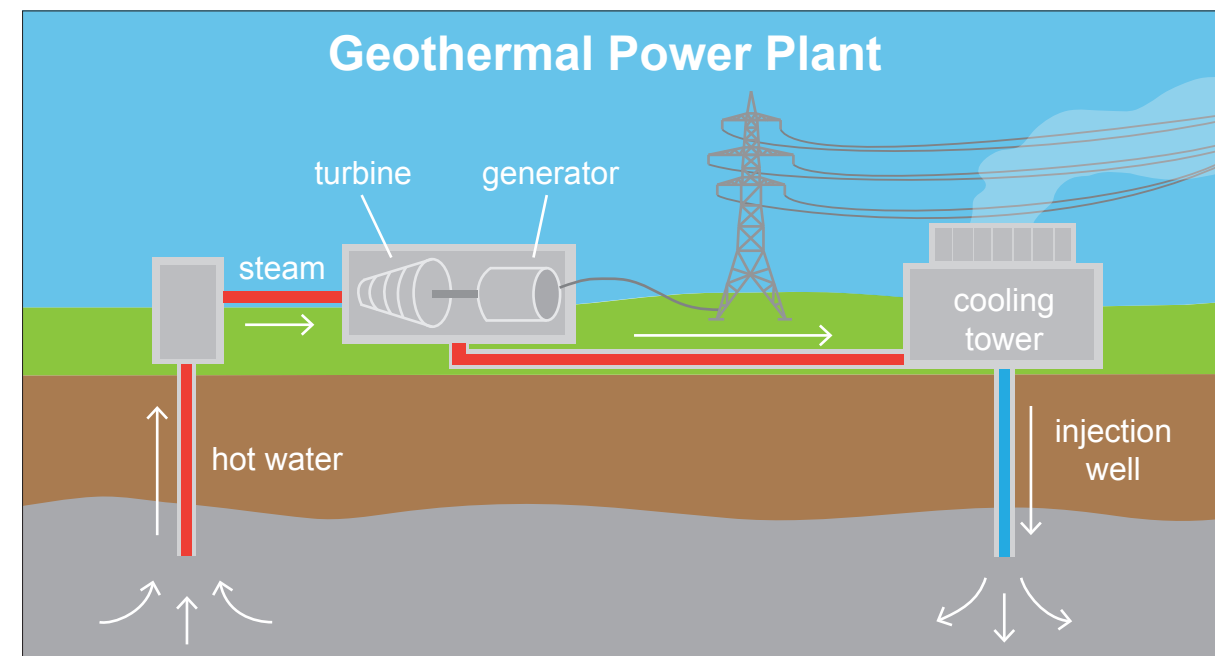
ESTIMATING POTENTIAL POWER GENERATION

Precise heat-flow measurements are needed in order to assess the likelihood of discovering a geothermal resource sufficient for power generation. To date, heat-flow data have only been collected from deep oil and gas exploration wells from Yukon's sedimentary basins.

In 2016, the Canadian Geothermal Energy Association and the Yukon government produced a report on Yukon Geothermal Opportunities and Applications (www.emr.ca/YTgeothermal). Based on the limited data available, the Yukon's geothermal energy potential is estimated at more than 1700 MW (megaWatt electrical) at a depth of less than 5 km. This is equivalent to approximately 18 times the 90 MW energy currently supplied by Yukon's renewable electrical system. The total cumulative potential power in Yukon was approximated to have an Inferred Resource of over 490 000 MW based on estimated heat resources down to a depth of 4.5 km. However, much of this estimated resource is from remote areas of Yukon, far from communities and the existing power grid. The Yukon Geological Survey is developing a research program that will measure heat flow and help evaluate the geothermal potential of areas closer to the Yukon's energy market, such as the Whitehorse trough between Carmacks and Carcross.



A schematic of Earth's geothermal gradient in the uppermost mantle (not to scale). Geothermal heat sources are derived at depth in the mantle and rise to near surface through fractures and porous rock in the Earth's crust. Image modified from Wiley & Sons, 1999.



Schematic diagram showing the components of a geothermal power plant.