

Geothermal Resources Prospecting

August, 2021

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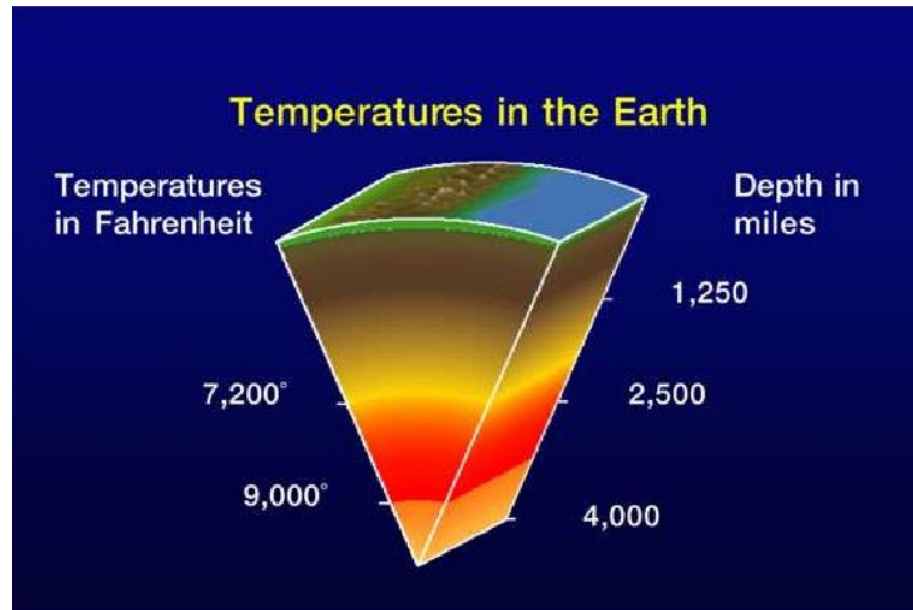
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In order to meet the 2015 Paris Climate Accord, signatory countries are attempting to reduce CO₂ emissions and thereby its potential impact on global warming. As importantly, major public and private industrial projects need to now pass Environmental, Social and Governance (ESG) scrutiny in order to gain social and investor acceptance. This is especially true for fossil fuel based projects which are increasingly evaluated on net carbon versus economic or strategic value alone.

Geothermal Energy Extraction provides a low carbon and environmentally friendly baseload power opportunity. It's extraction also leverages the Upstream Oil and Gas industries technical skill set.

What is Geothermal Heat?

- Geothermal is related to the thermal energy of Earth's interior. Thermal energy increases as we get deeper, closer to the earth's center. A global average for Earth's geothermal gradient (temperature increase with depth) is approximately $30^{\circ}\text{C}/\text{km}$. This heat is used in a geothermal power plants to drive a steam turbine, which in turn creates electricity. Any additional heat generated can be used in a variety of industrial heating applications.
- Geothermal heat requires three key variables;
 - ◉ **Heat**
 - ◉ **Permeable rock** to transfer heat
 - ◉ **Medium** (typically water) to bring the heat resource to the surface



The deeper you go, the hotter it gets (in Fahrenheit and miles).
Slide 4 of 122, © 2000 Geothermal Education Office

Mission:

Develop Commercially Economic Geothermal Energy



Mission

- Identify viable Aquifers as Geothermal Heat Source Targets
 - ◉ Pilot Project – 150 Kw
 - ◉ Commercial Project 5-20MW
 - ◉ Full Field Development 100-200 Mw?
- Locate proximal to transmission/distribution networks – minimize tie-in costs

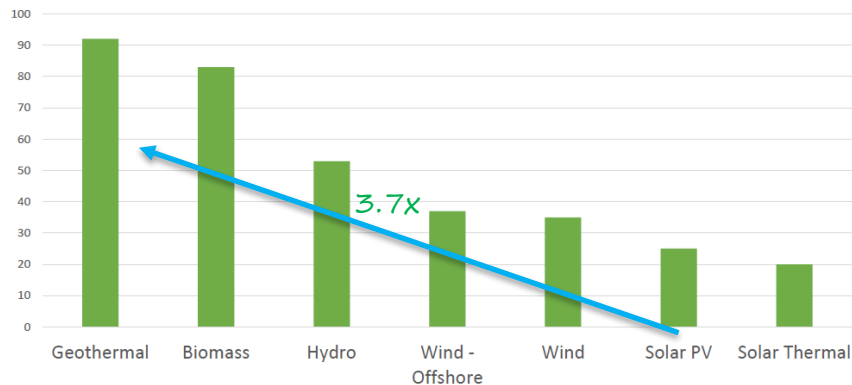
Outline

- Current Projects
- Optimizing Basinal Heat Flow and Geothermics
 - ◉ Devonian Reef Opportunities
 - ◉ Basal Cambrian Sand Opportunities
- Regulatory Framework
- What's Next

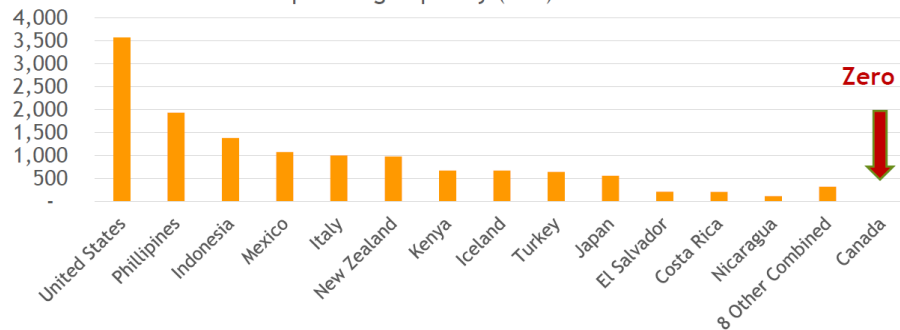
Why Geothermal (>90% baseload, 14.9 GW Global, Zero Canadian)

100MW GT = 370 MW Solar = 0.5Mt/yr CO₂ offset

Capacity Factor (%)

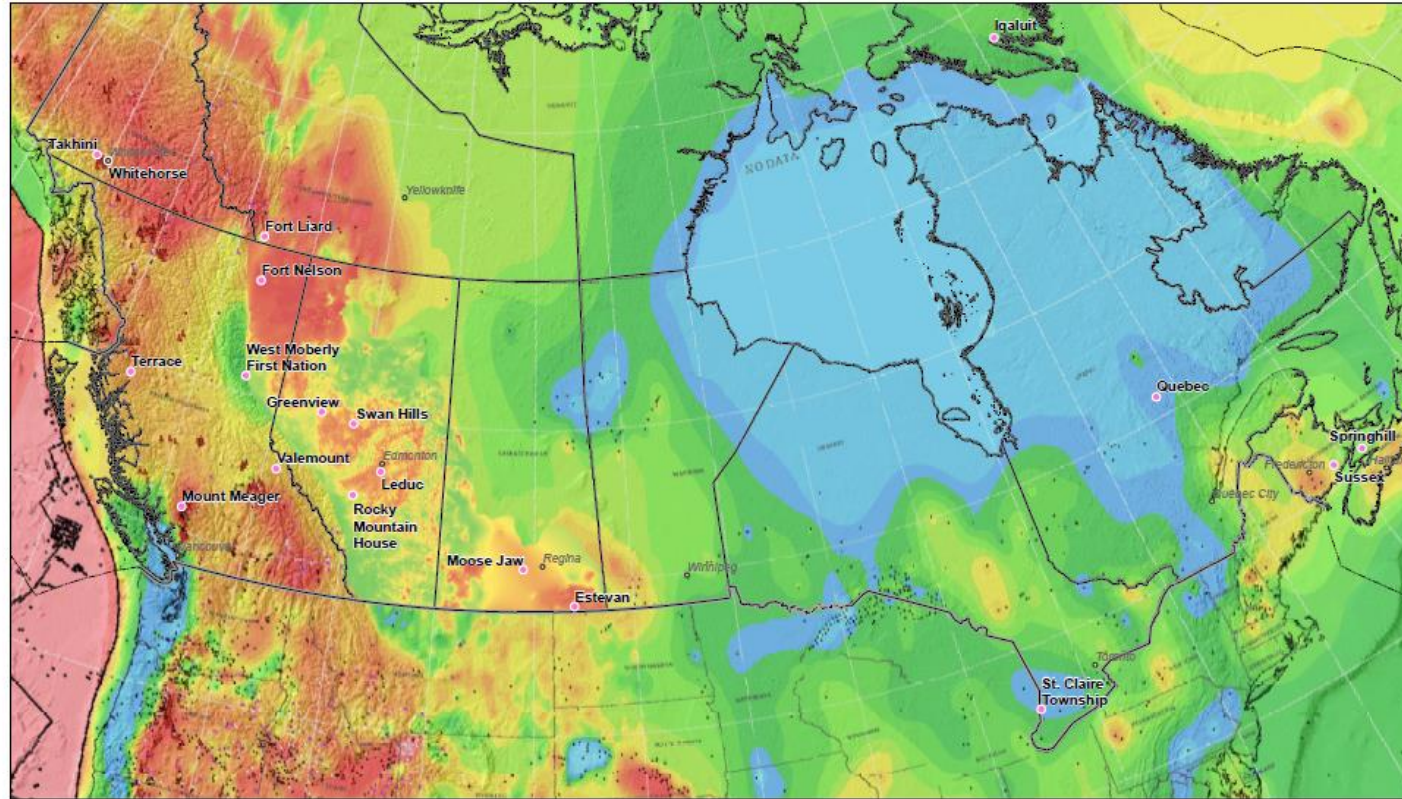


Operating Capacity (MW) TODAY



- Clean, renewable and reliable source of power and heat; produces baseload power with 95% availability
- Proven technology that provides a baseload power, had no emissions and a small environmental footprint for power supply.
- Low carbon emissions, equivalent to an eighth of the carbon emissions linked to common coal power
- Has the potential to produce more electricity over the same time period than coal, natural gas, nuclear and hydro stations

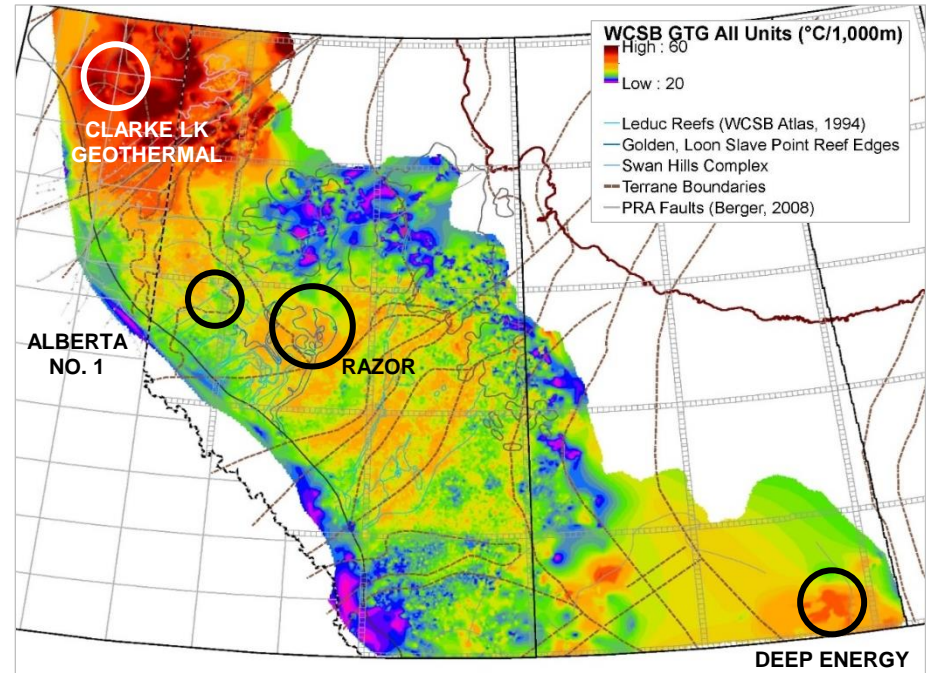
Big Picture: Geothermal Gradient and Projects Across Canada



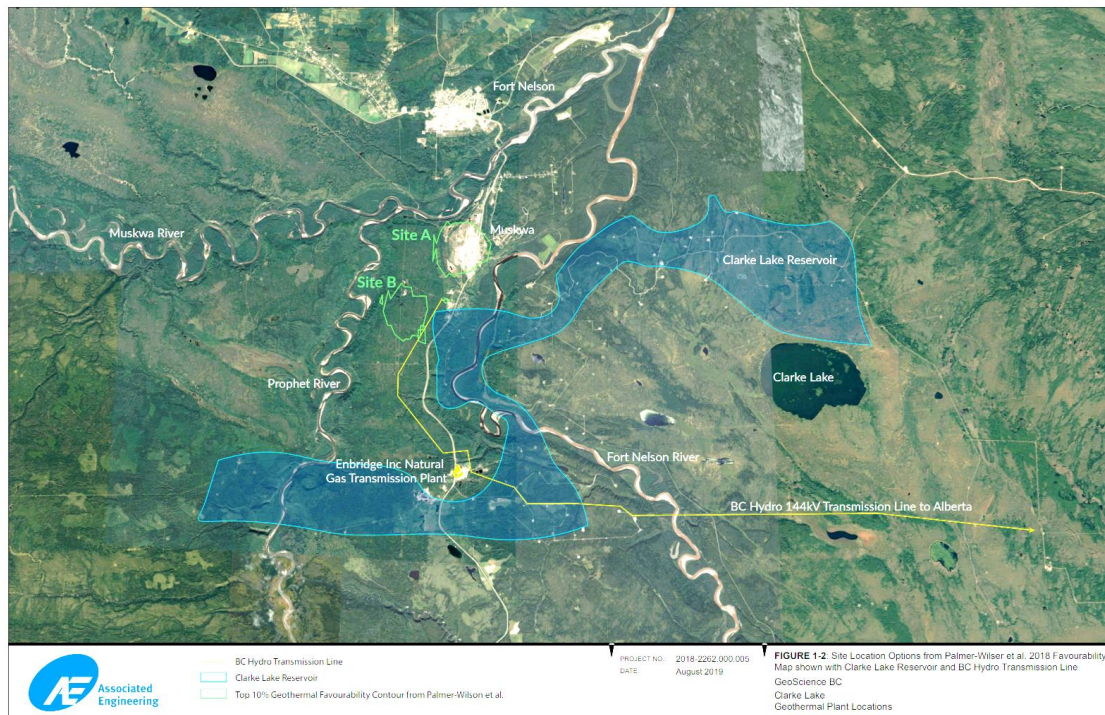
- 20 Geothermal projects or feasibility studies across Canada
- Hotter colours (yellow-red) = higher subsurface temperatures; meaning greater potential for success with Geothermal projects

WCSB Geothermal Gradient; A Sharp Picture of Basinal Heat Flow and Basement Terrane (n~340,000)

- Harvesting heat from high water cut wells, utilizing existing oil & gas infrastructure. Heat supply security validated with up to 60 years of reservoir and production data. Hot spots identified within the Western Canadian Sedimentary Basin (WCSB)
- CDL Geothermal Gradient map indicates areas of high basement heat flow
 - ◉ Clarke Lake Slave Pt. Reservoir Hot Spot
 - ◉ Alberta No. 1 Grand Prairie, Swan Hills Test Site
 - ◉ Razor, South Swan Hills High Water Production
 - ◉ Deep Energy Williston Cambrian



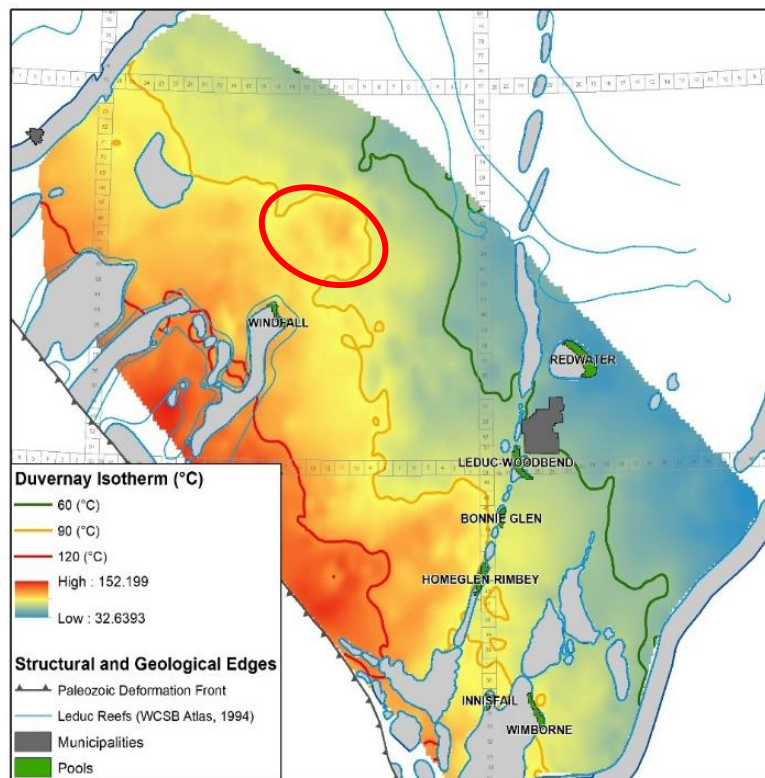
Clarke Lake Geothermal Project



- Located in NE British Columbia
- Natural Resources Canada has announced funding of CAD \$40.5 million for the Clarke Lake geothermal project in the Province of British Columbia.
- 7 – 15 MW Project Scope, 100% owned by Fort Nelson First Nation (Deh Tai, economic development arm).
- Designed to re-purpose the Clark Lake gas field as on of Canada's first commercially viable geothermal electricity production facilities.
- Facility will consist of Organic Rankine Cycle turbines, with heat estimated to be around 120°C.

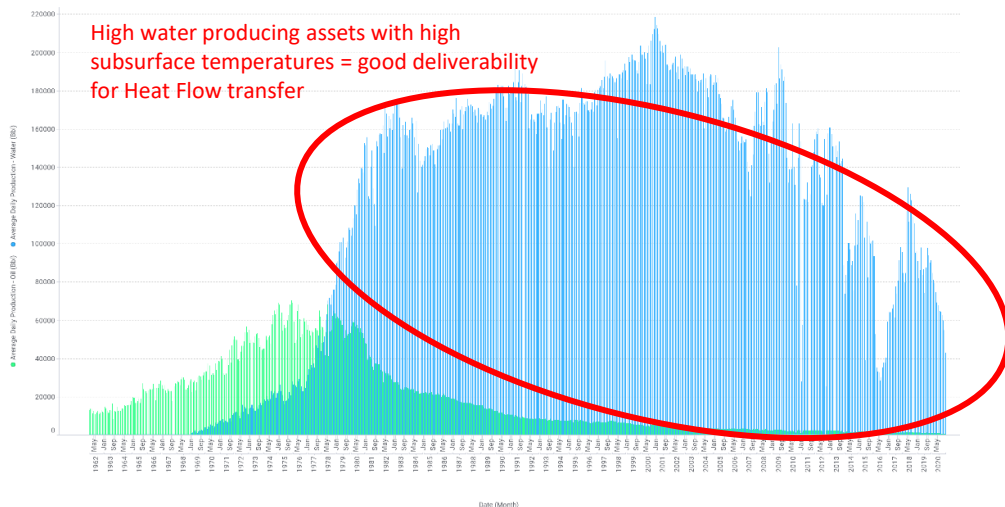
FutEra-Razor Joint Venture; Devonian Reef Opportunities Co-Produced Geothermal Natural Gas Hybrid Power Project

Duvernay Isotherm; Located in North-Central Alberta

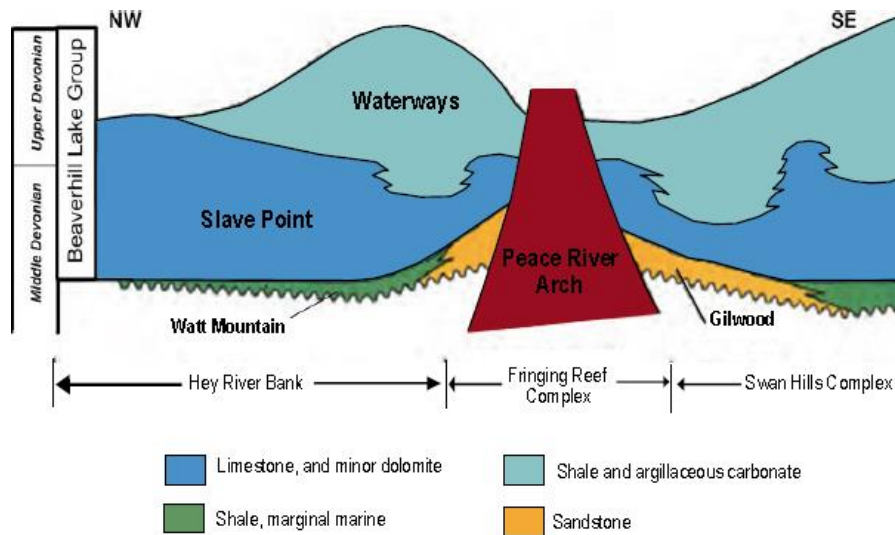
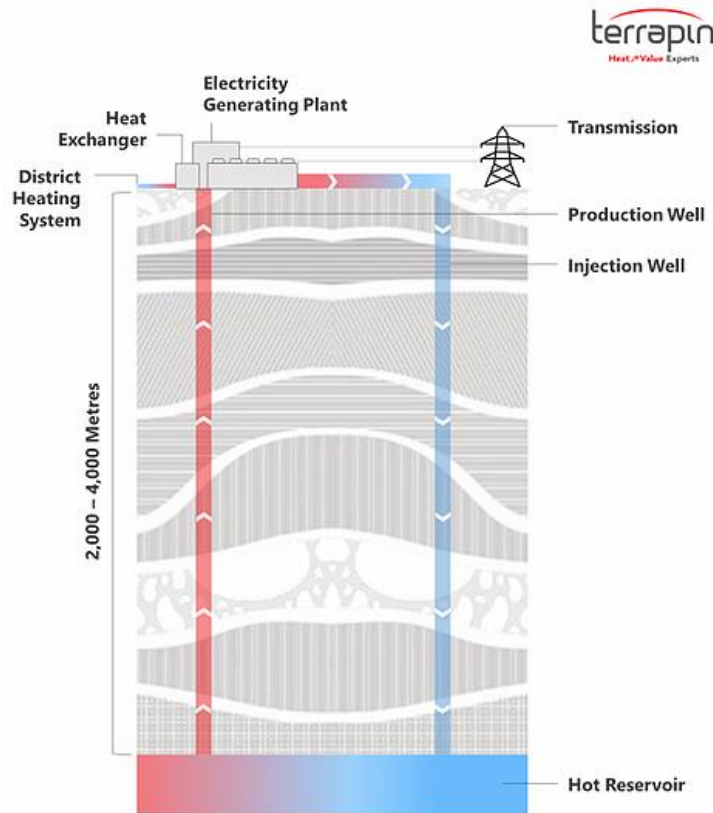


Water Production and Swan Hills Aquifer Capability

South Swan Hills Reef Unit



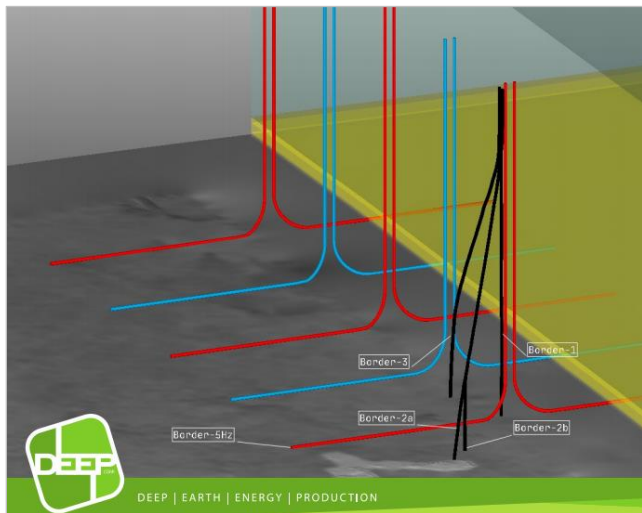
- 21 MW of heat & Natural Gas generations
- reduces emissions by 31, 000tCO₂e/year
- Measurable GHG reduction
- Re-purposing existing assets with no new footprint



Schematic showing the bedrock interface; with Watt Mountain and Gilwood formations as the prime targets for fluid production for geothermal.

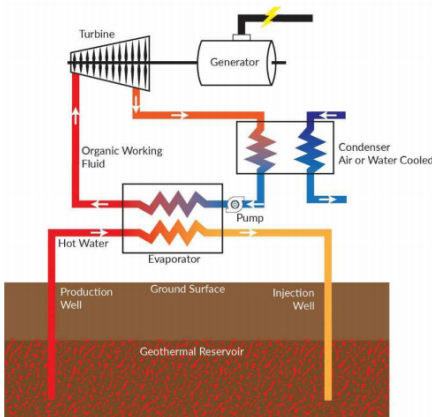
- Alberta #1 is a binary power plant utilizing a geothermal resource of 118°C
- Estimated 10 MW of clean electricity and 985 TJ/year of clean heat offsetting over 97,000 tones of CO₂ annually.

- Located in Southern Saskatchewan – using oil and gas technology and expertise for renewable energy
- DEEP 20 MW power project will use 6 hz producers (red) and 4 hz injectors (blue) at 1.0 mile inter-well spacing
- Large diameter wells to handle large ESP
- Brine produced at 122°C in prod/injection loop test
- Subsurface footprint for 20MW is 15 sections, surface footprint is 300 by 300m
- Eventual 100MW DEEP development to require 75 sections (2 townships), will light up 100,000 homes



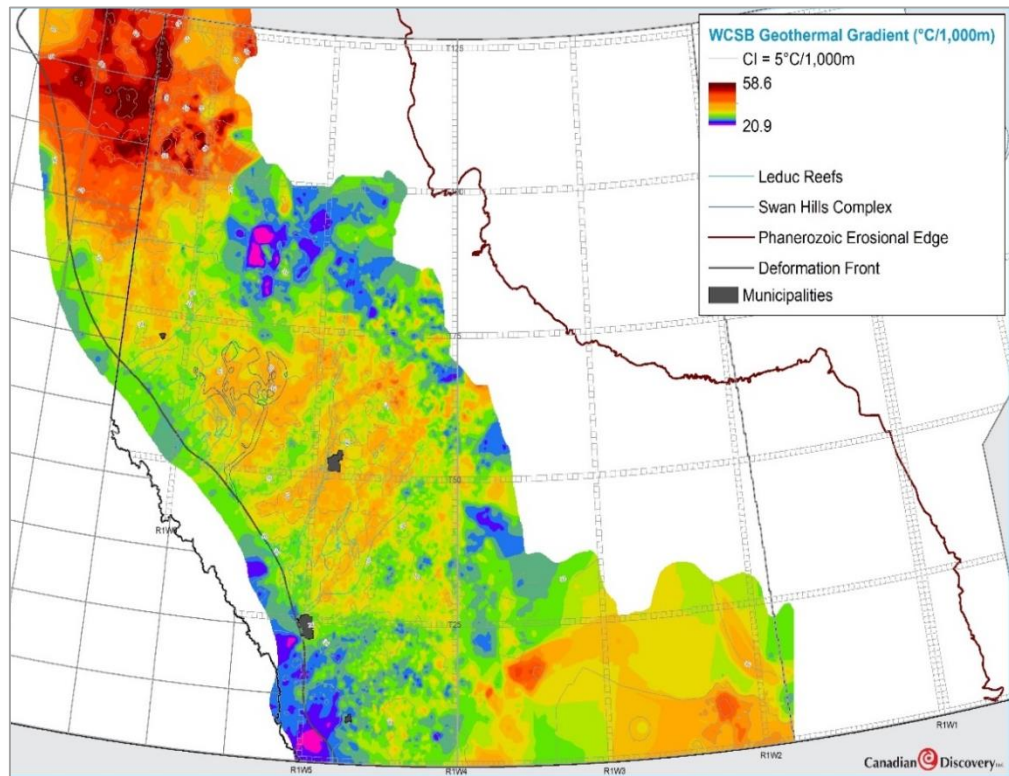
Source: DEEP

POWER GENERATION TECHNOLOGY – ORGANIC RANKINE CYCLE (ORC)



- Proven technology >40 years of field implementation around the world
- Wells drilled into a geothermal reservoir produce hot water and steam from a depth of up to 3 km
- The geothermal energy is converted at a power plant into electricity
- Hot water and steam are the carriers of the geothermal energy

- Producing basin scale atlas'
 - Hydrogeology of Western Canada, Williston Basin, Green R. Basin, Wind R. Basin, Delaware Basin, Oriente Basin, Llanos Basin, N. Sea etc.
 - Hydrocarbon Chemistry Atlas'
 - Stress Analysis of Central Alberta
- Basin scale pressure and fluids analysis
- Geothermics
- Reservoir characterization
- Seal analysis
- Geomechanics
- Geochemistry



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