Geothermal Opportunities – the doors are opening

Dr. Catherine Hickson

President, Geothermal Canada

CEO, Alberta No. 1

Tuesday, June 2, 2020

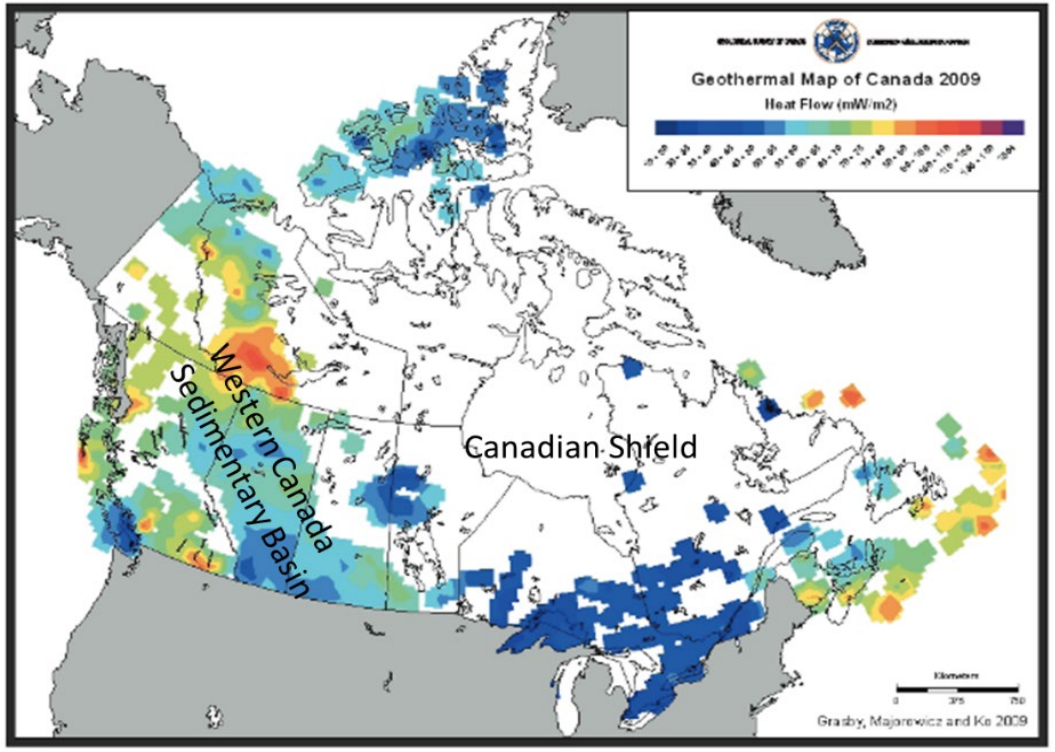
GEOTHERMAL CANADA

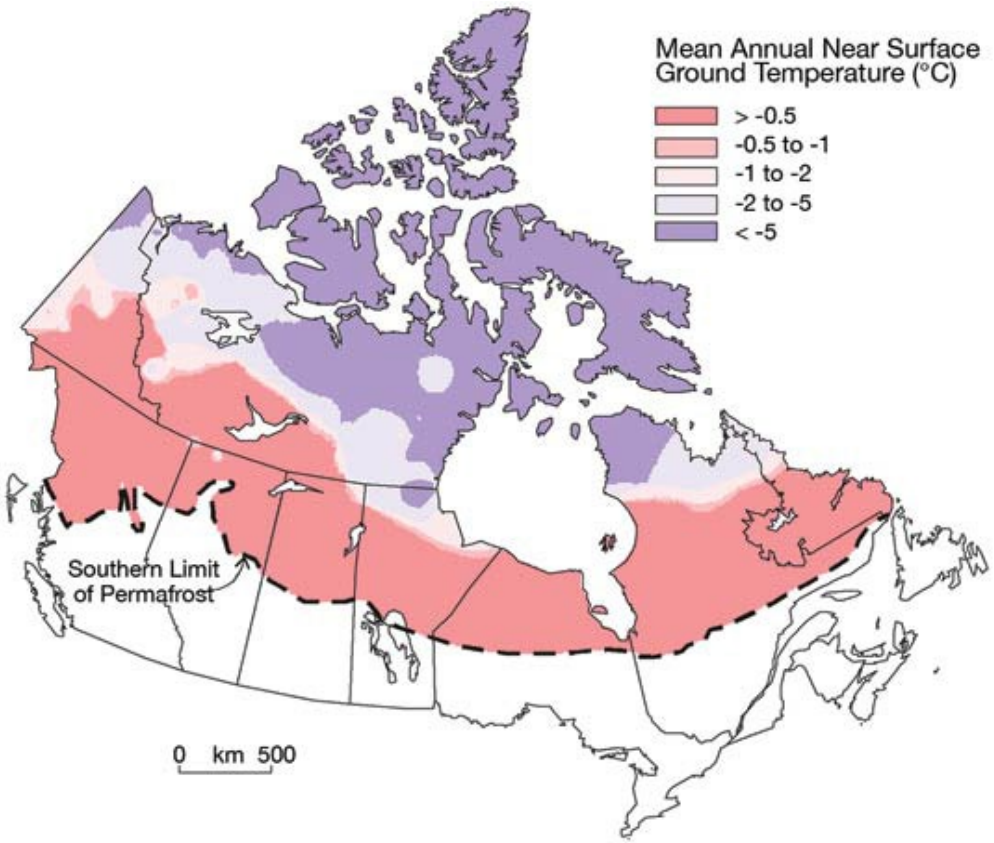
The objectives of the Society are:

- To advance science and promote geothermal research in Canada
- To promote innovation in Canada in geothermal research
- To foster collaborative investigations between academia, companies and organizations in the field of geothermal research

Pan Canadian Society for Geothermal Research, Innovation & Collaboration

The Importance Of Geothermal To Canada





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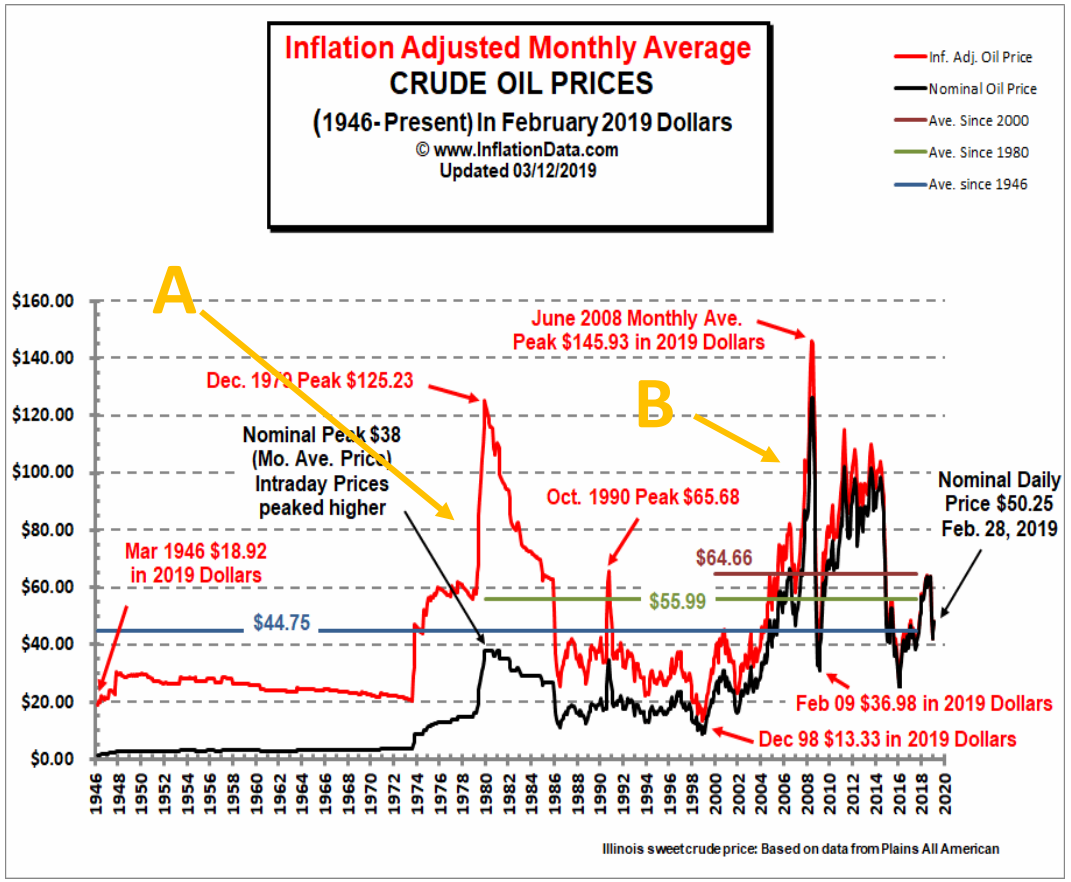
Geothermal History in Canada



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Much of Canada's economy has been driven by the price of hydrocarbons. Geothermal has been driven by these peaks and valleys. During the mid 1970 (**A**), during the world oil crises the Canadian government invested approximately 100 million (1974-1985: 2019 dollars) in geothermal exploration. Again in the mid to late 2000s (**B**), geothermal energy saw an significant increase in interest from the private sector. In both cases, interest plummeted when the price of oil also plummeted. Now the increased interest is being driven by a change in thinking; decreasing GHGs and sustainability.

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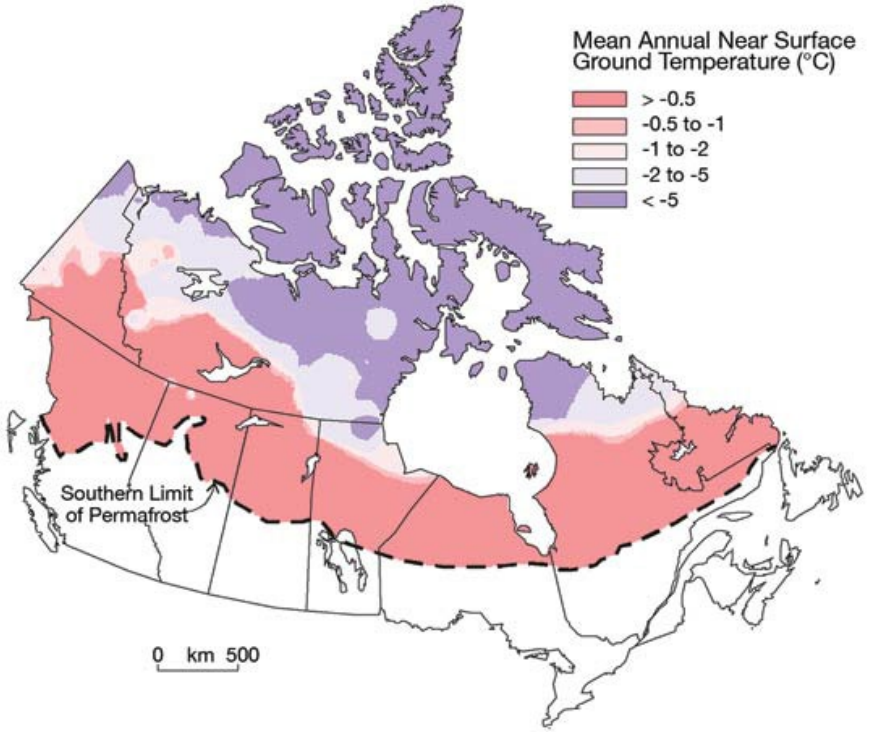
Extreme climate

Arctic to subarctic climate

- Permafrost conditions
- High heating loads

  > 8000 degree-days
- Mean annual temperatures of less than zero degrees Celsius



Most Energy needs are supplied by fossil fuels

Geothermal can:

- Generate electricity.
- Heat buildings.
- Carbon offset potential.
- Reliable alternative to hydrocarbons.

THE POWER OF ΔT (TEMPERATURE DIFFERENCES)

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The Power Of Δt (Temperature Differences)

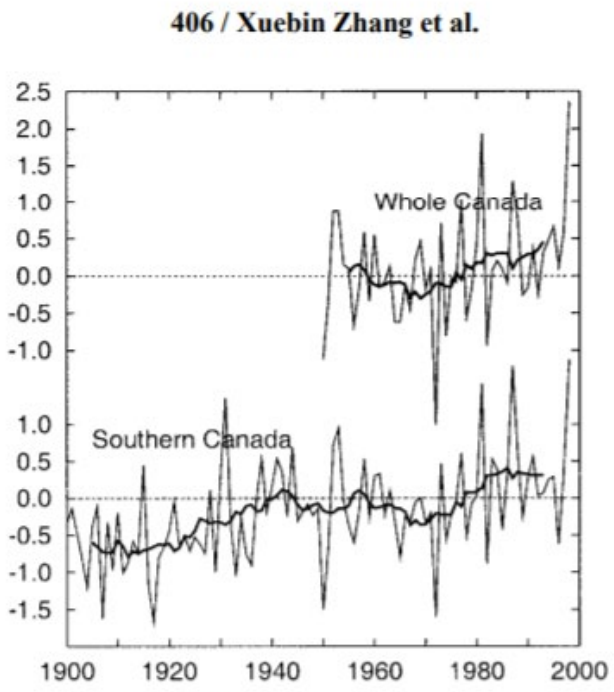

Fig. 3 Departures from the 1961–1990 mean of area average mean temperature (°C). Bold curves are 11-year moving averages.

Northern Alberta

January temperatures: daily averages

High °F	Low °F	Place	High °C	Low °C
14	-4	Cold Lake	-10	-20
2	-17	Fort Chipewyan	-17	-27
10	-8	Fort McMurray	-12	-22
18	-2	Grande Prairie	-8	-19
5	-14	High Level	-15	-26
15	-3	Slave Lake	-9	-19

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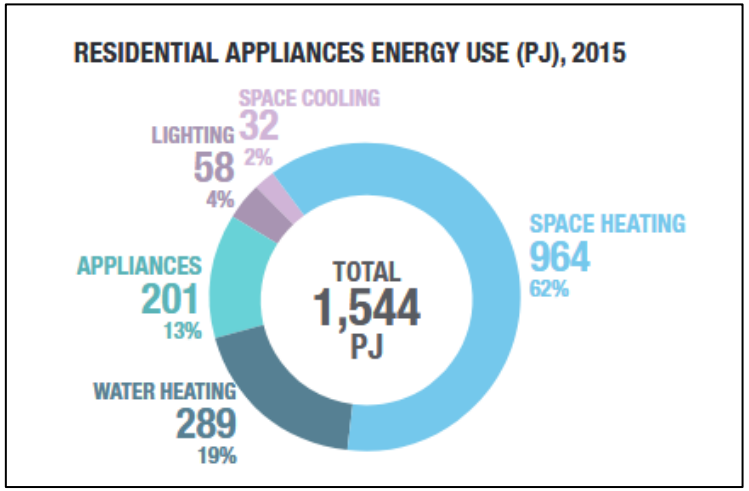
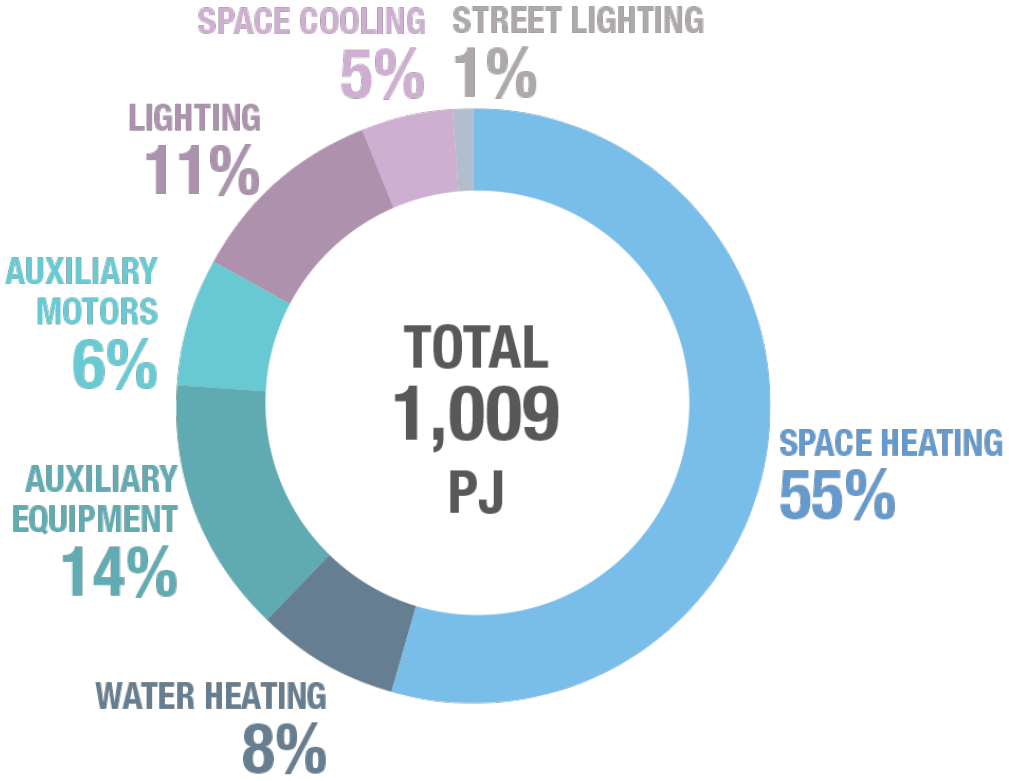
Importance of heat

Energy consumption: Huge requirement for space heating in Canada.





THE POWER OF ΔT (TEMPERATURE DIFFERENCES)

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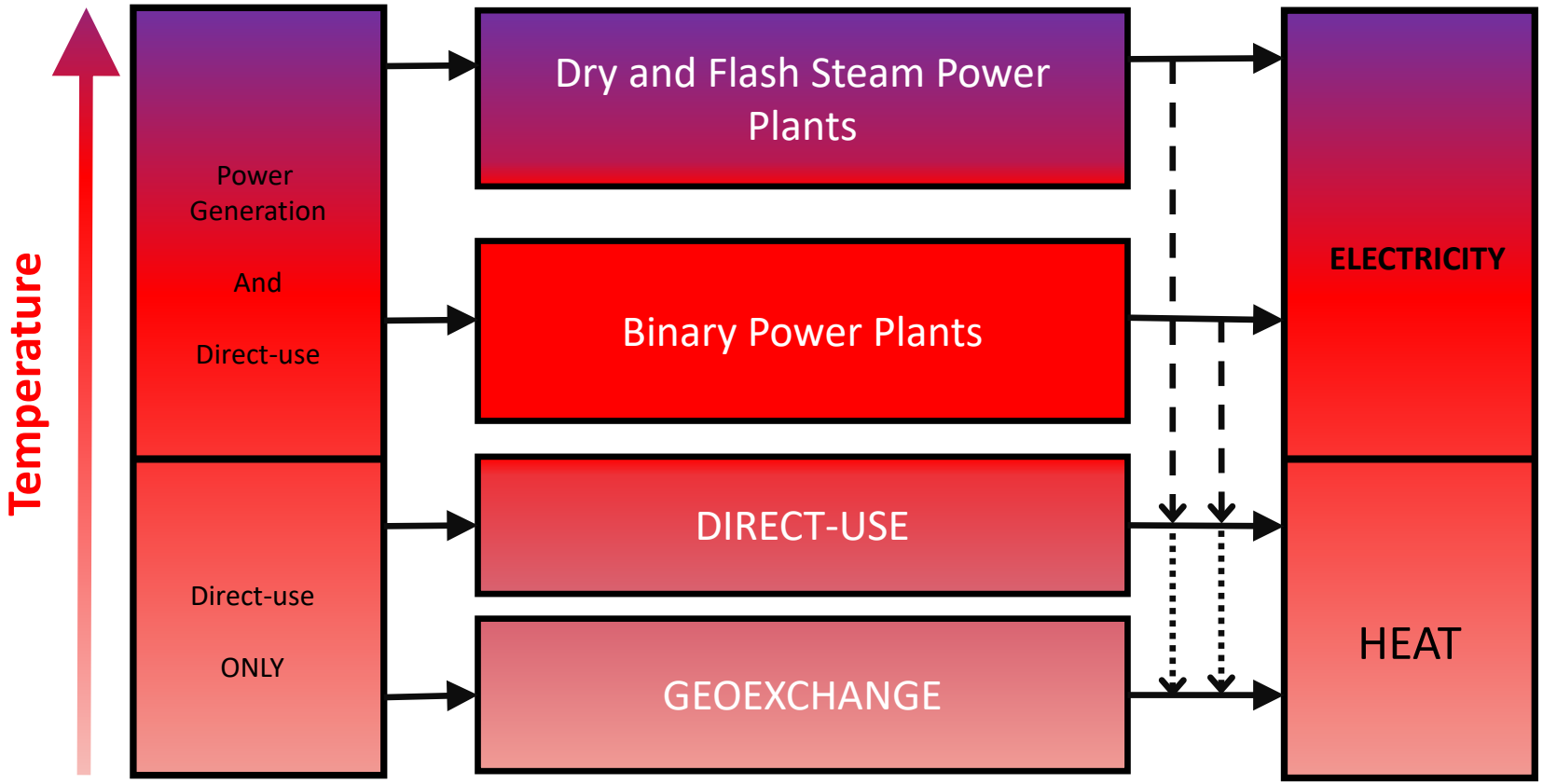
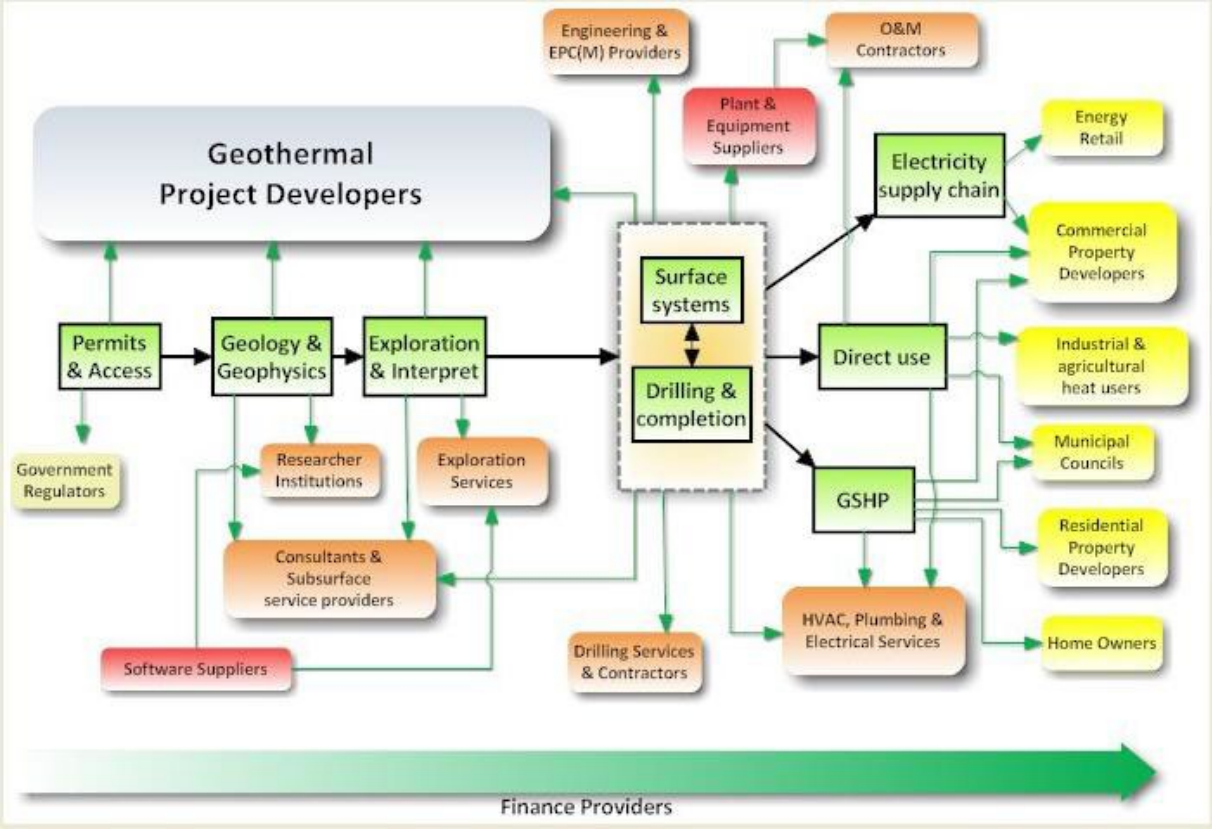
The Geothermal "Spectrum"

Power Production → Direct-use → GeoExchange (Geothermal Heat Pumps)



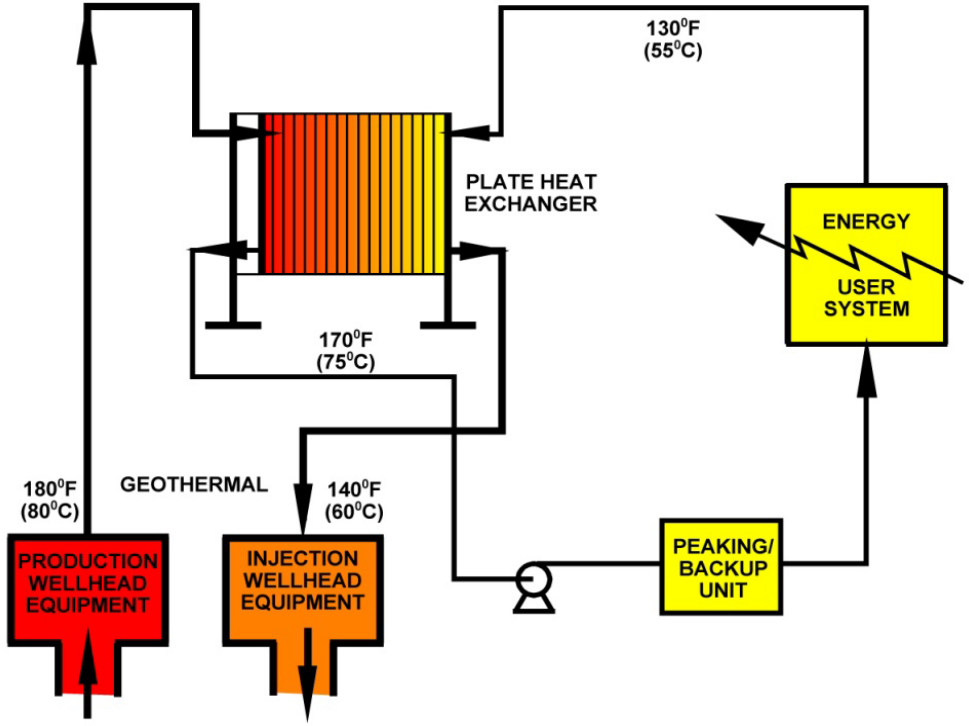
Power → Deep Geothermal (Direct-use) → GeoExchange

Ground source heat pump, direct use and geothermal power industry value chain map



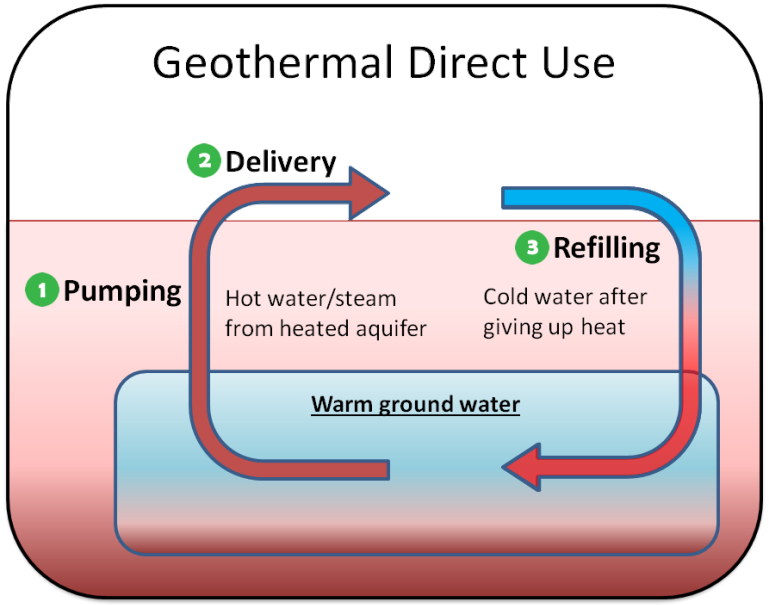
Source: http://www.ausicom.com/news-419-opportunities-to-exploit-geothermal-energy-begin-to-heat-up

Geothermal Extraction



1. Fluid is pumped from the well and used directly or through a heat exchanger to transfer heat to the application

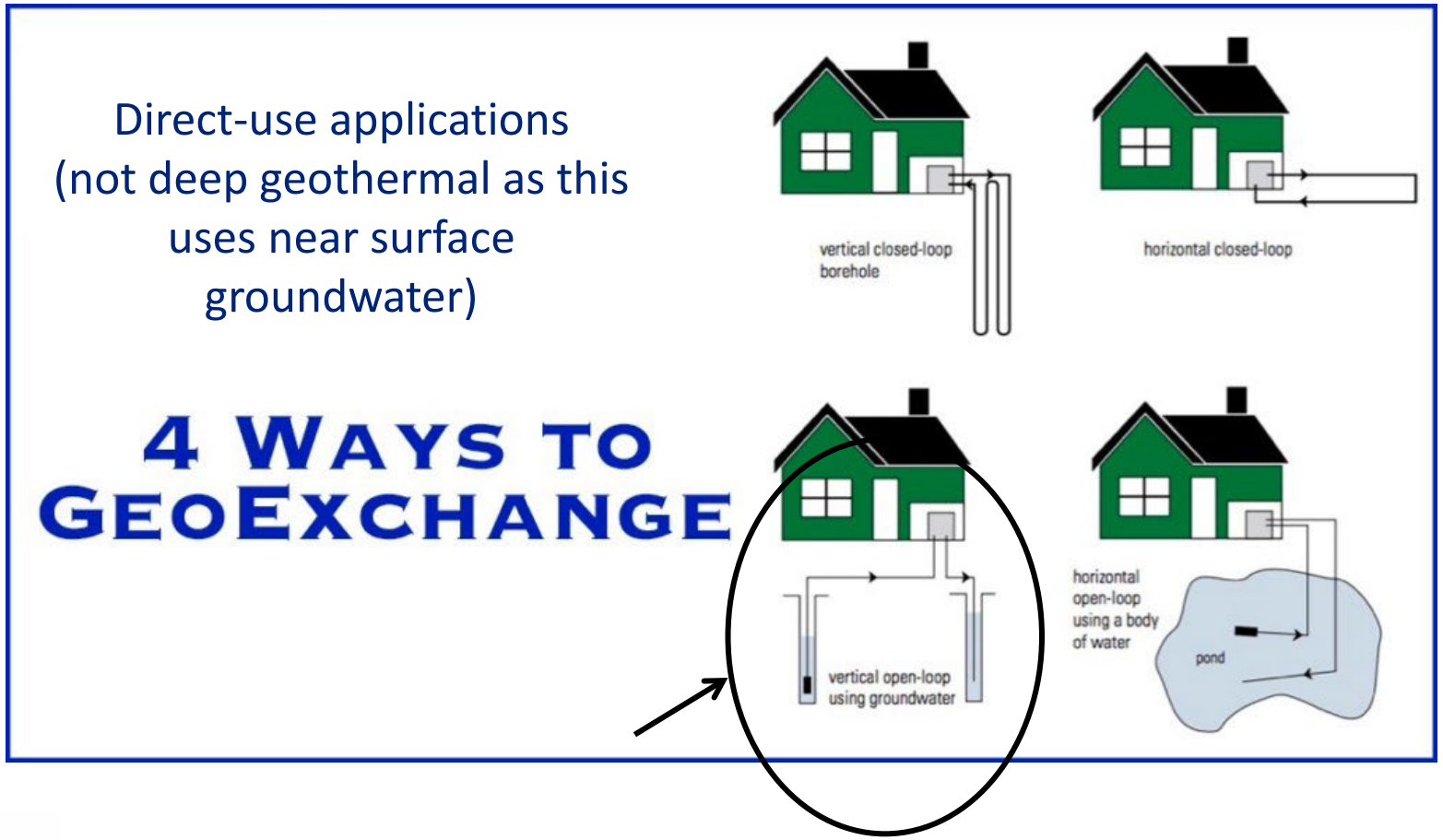
2. A closed loop downhole heat exchanger (DHE) is installed in the well and a secondary (aka binary, transfer fluid) is used to transfer heat to the application



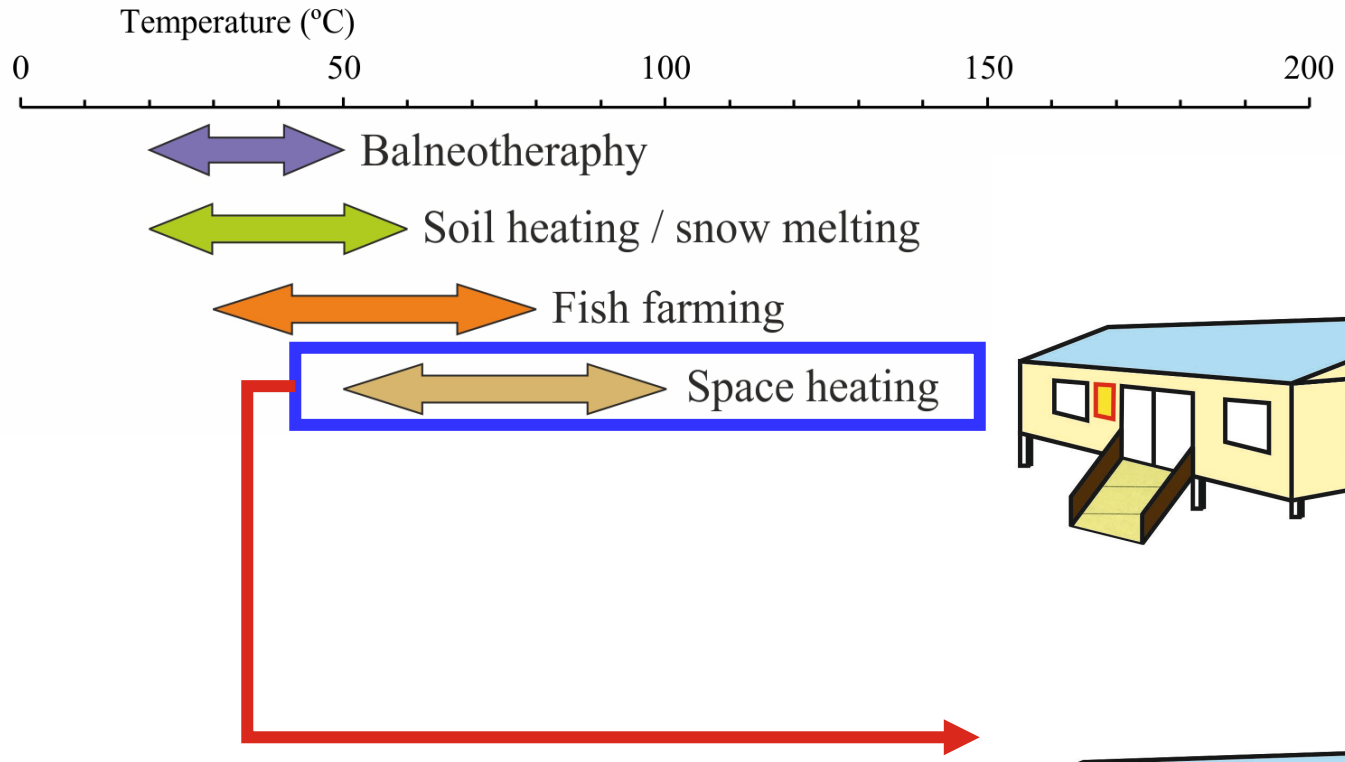
Geothermal Extraction

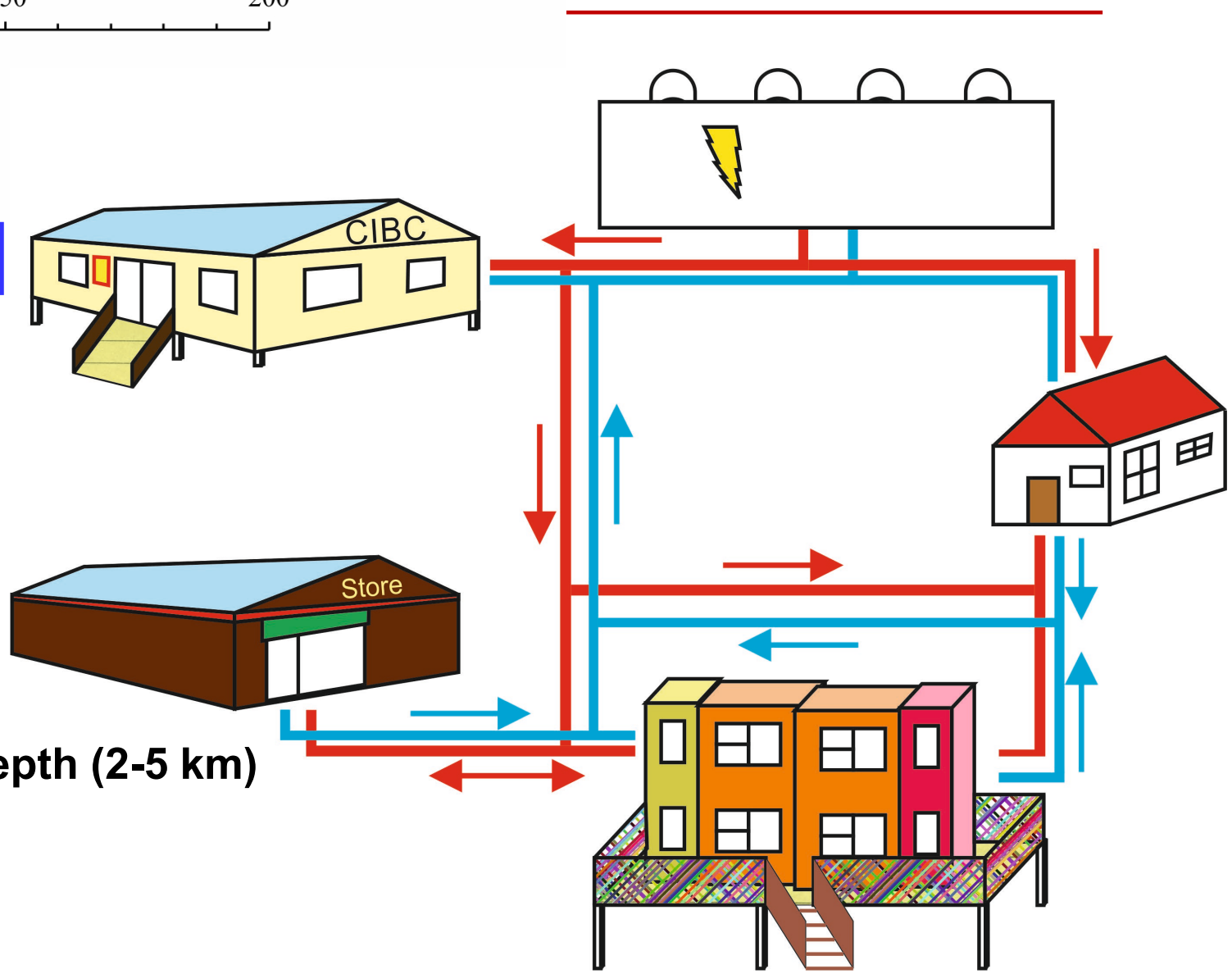
Extraction – Small GeoExchange systems

Direct-use applications
(not deep geothermal as this uses near surface groundwater)



Direct Use Energy Applications





District heating system

Estimation of the temperature field at depth (2-5 km)

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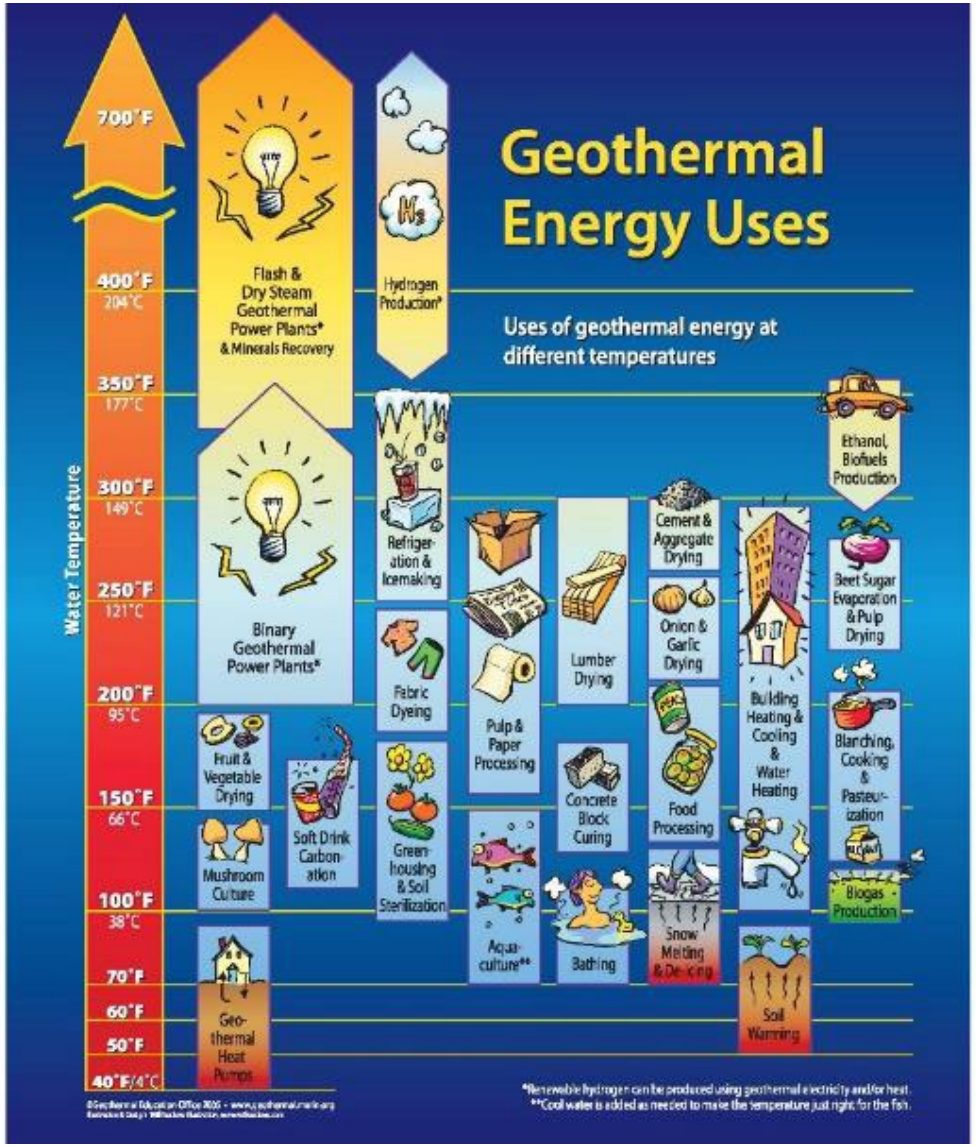
Direct-use Energy Applications

Deep Geothermal has many more options then geoexchange

Thermal applications include:

- Heating buildings
- Timber drying
- Crop drying
- Industrial process heating
- Commercial greenhouses
- Snow melting

Friðheimar greenhouse and restaurant, Iceland



Geothermal Education Office, 2005

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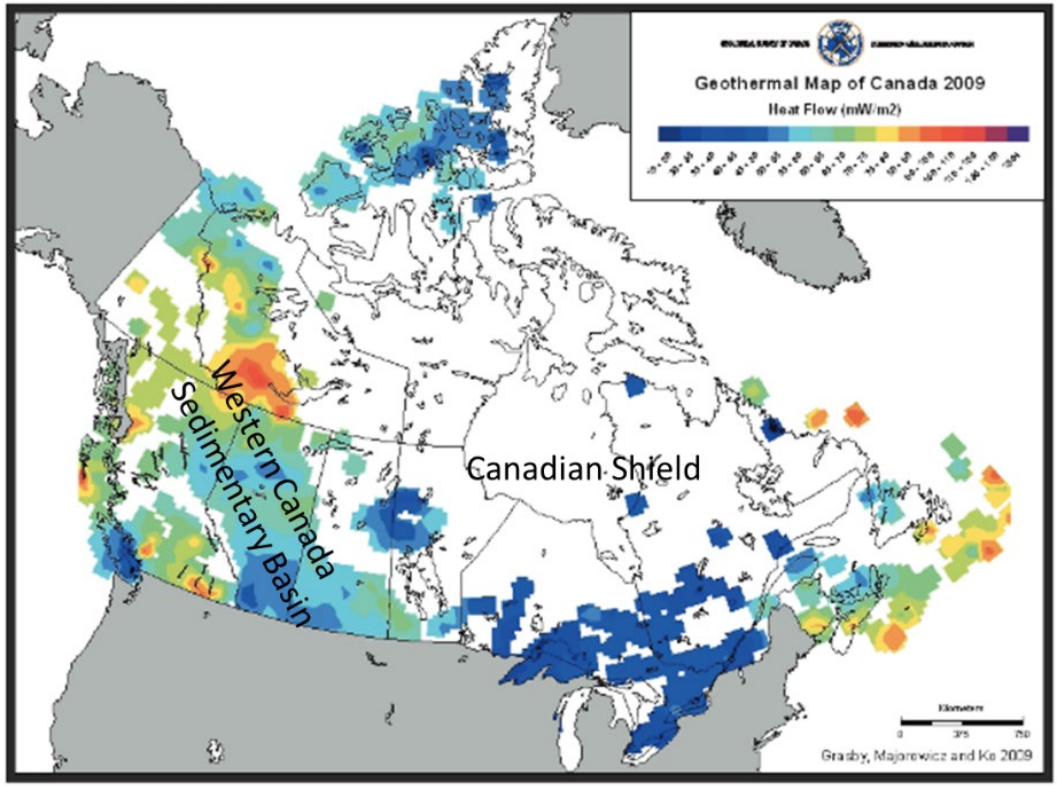
Research, Innovation & Development in Canada



From assessment to development

- Western Canada sedimentary basin (BC, Yukon, Alberta, Saskatchewan)
- Fault controlled non-volcanic systems (BC)
- Volcanic systems (BC)
- Northern potential in sedimentary basins (Nunavut, Yukon, NWT)
- Crystalline basement (Canadian Shield)

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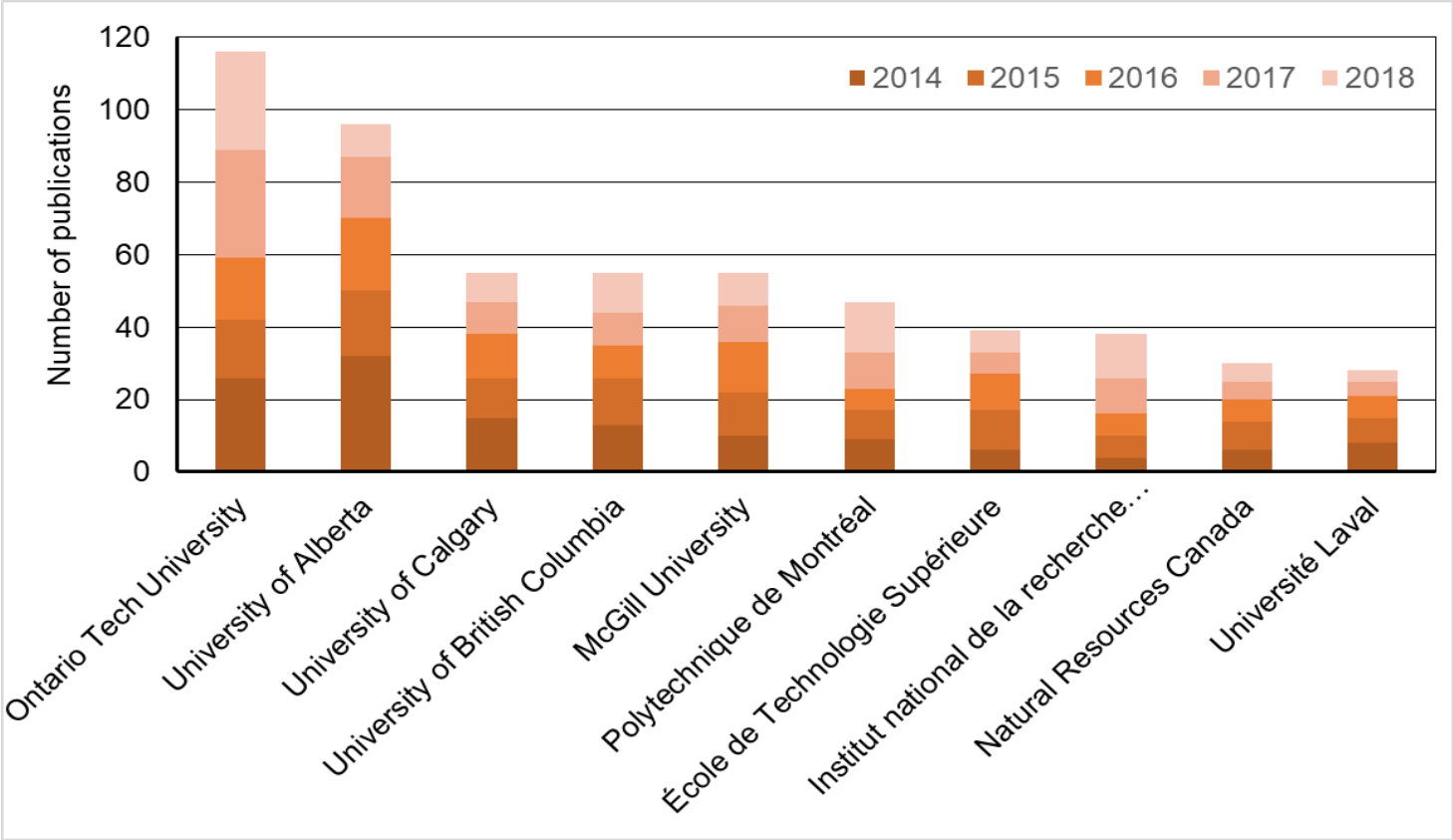
Research & Innovation (University)

Scopus review shows the Canada ranks #7 in the world for geothermal publications over the past 5 years.



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Direct Use Energy Applications - Current

Canada currently ranks 7th in the world in term of direct heat use – but there is much more to be done!

	GWh/yr
China	48,435
Iceland	7,422
Japan	7,259
Germany	5,426
Finland	5,000
France	4,408
Canada	**3,227**
Hungary	2,852
Italy	2,412
New Zealand	2,395

Global direct heat use (includes Geoexchange) (from NRCan)

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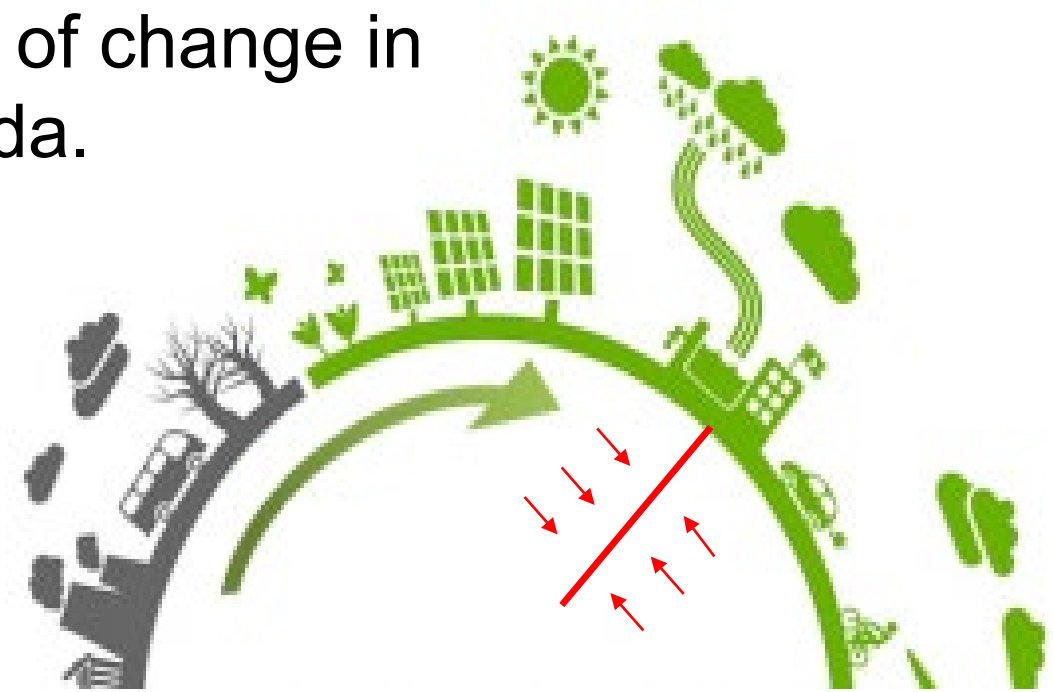
The Future Energy Alternatives for Canada – kickstarting an industry

The green economy as a driver of change in Canada.



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Federal funding (Natural Resources Canada) for Geothermal projects is finally coming to fruition. Close to **$70,000,000** is being committed to support geothermal:

Development Projects:
Alberta #1, Alberta
DEEP, Saskatchewan
R&D:
Barkley Project Group , British Columbia
Eavor, Alberta
Razor, Alberta
Geological Survey of Canada/NRCan, Garibaldi, British Columbia

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The role of Government

What is needed for geothermal development?

- Government recognition that geothermal resources will fill the basic infrastructure needs of the north and support continued development and occupation of the land (sovereignty).
- Like bridges, roads and highways, geothermal energy must be considered "infrastructure" and the costs born across the tax payer base of Canada. "What is good for the north is good for the rest of Canada."
- Projects in Finland, Sweden, Denmark and elsewhere are proving EGS technology; Canada needs to get on-board and support geothermal.

[presentation January 2019]

Economic Considerations

1. Project development
   a. Exploration and evaluation of the resource
   b. Exploration drilling
   c. Production drilling
   d. Surface piping and infrastructure
   e. Plant design and construction (CAPEX)
   f. Operation (OPEX)
2. Social economic factors – local employment
3. Electrical Generation income - PPA
4. Direct-use income – thermal
5. **Carbon Off-set income – thermal and electrical**

[presentation January 2019]

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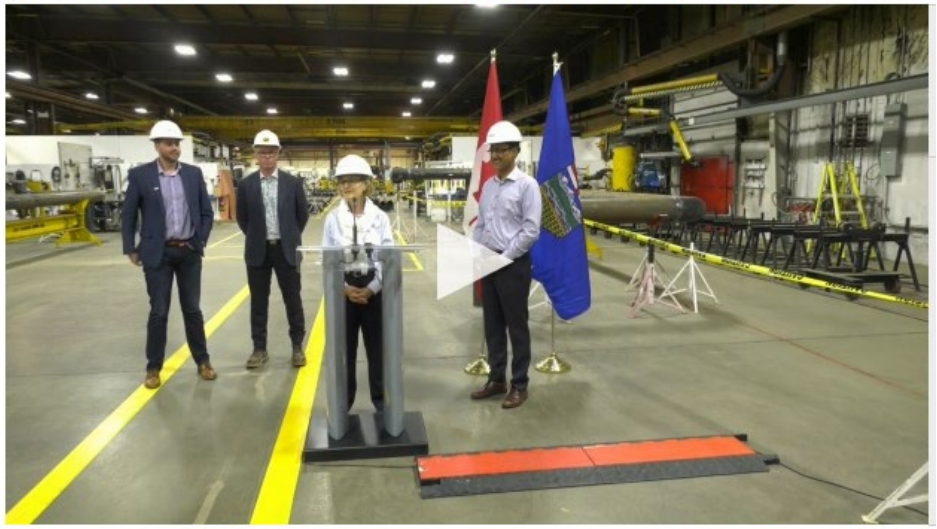
Role of Government:
Press Release Announcement, August 23, 2019

Geothermal power plant coming to MD of Greenview



Conventional geothermal heat & power project in Alberta, Canada secures government funding

Terrapin Geothermics event at Greenview, Alberta, Canada (source: Terrapin Geo)

Press Release Announcement

August 23, 2019

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Partially Funded by Natural Resources Canada
Financé partiellement par Ressources naturelles Canada
Canada

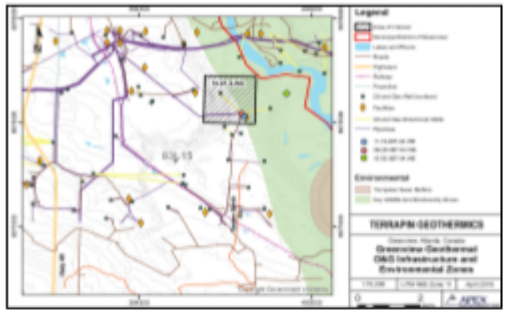


Figure 1. Area map of existing oil and gas wells and infrastructure in the target area (black section)

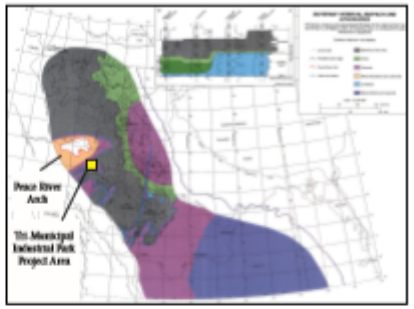


Figure 3. The TMIP lies on the southern edge of the Peace River Arch (PRA) (AER 1994).

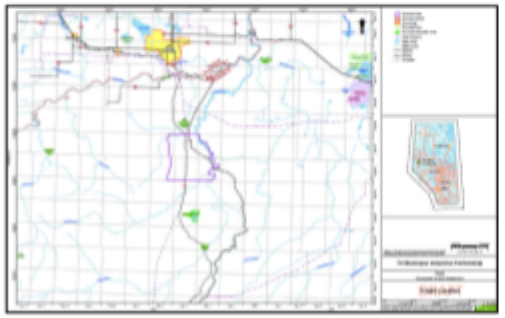


Figure 2. Regional Base Map of the TMIP (purple outline) south of the City of Grand Prairie (yellow block) within the boundaries of the MDGV.

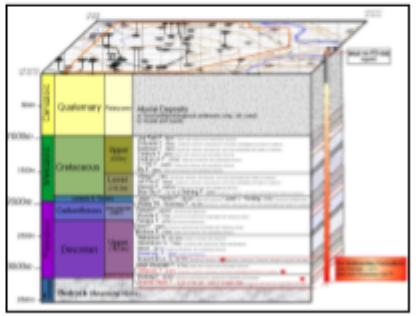
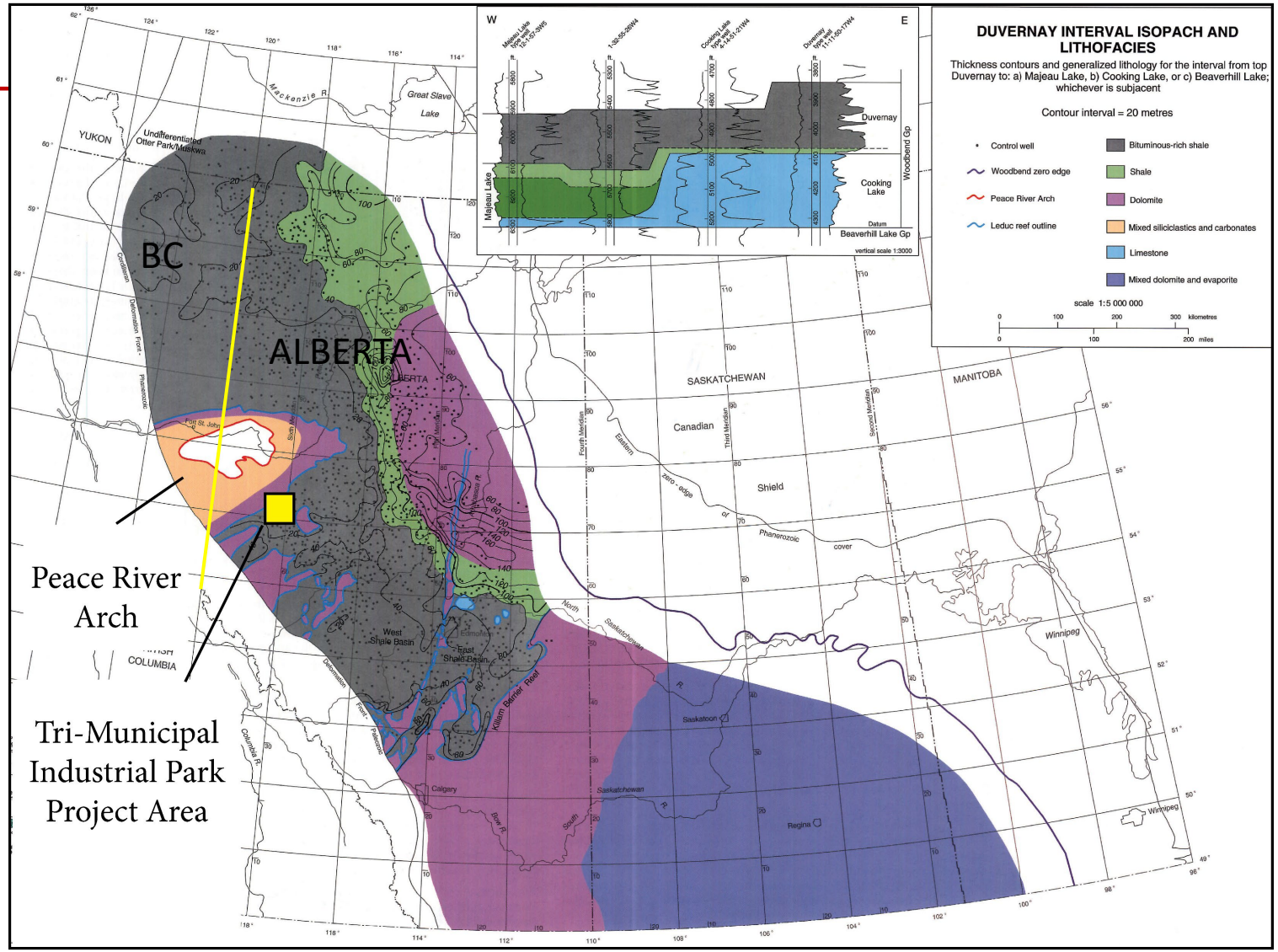


Figure 4. Stratigraphy column of formations in the TMIP. The sub-Duvernay formations are the permitted stratigraphy and include the basement.

Alberta #1 is a consortium composed of Terrapin Geothermics, PCL Construction, Municipal District of Greenview and NRCan Emerging Renewable Power Program. The target is highly permeable limestone strata 120°C and 3,500 – 4,500 m in depth.

Project Location

Western Canada Sedimentary Basin – Sedimentary rocks overlying crystalline rock of the Canadian shield – it extends into BC.



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Value of the Thermal Energy

Alberta No. 1 (5MWe net) anticipated to flow 300 liters/sec. The heat value of the flow is equivalent to **<u>40 barrels of oil an hour</u>**!!

350,000 barrels a year

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Putting all that hot water to use!

List of things that can be done with the energy huge!

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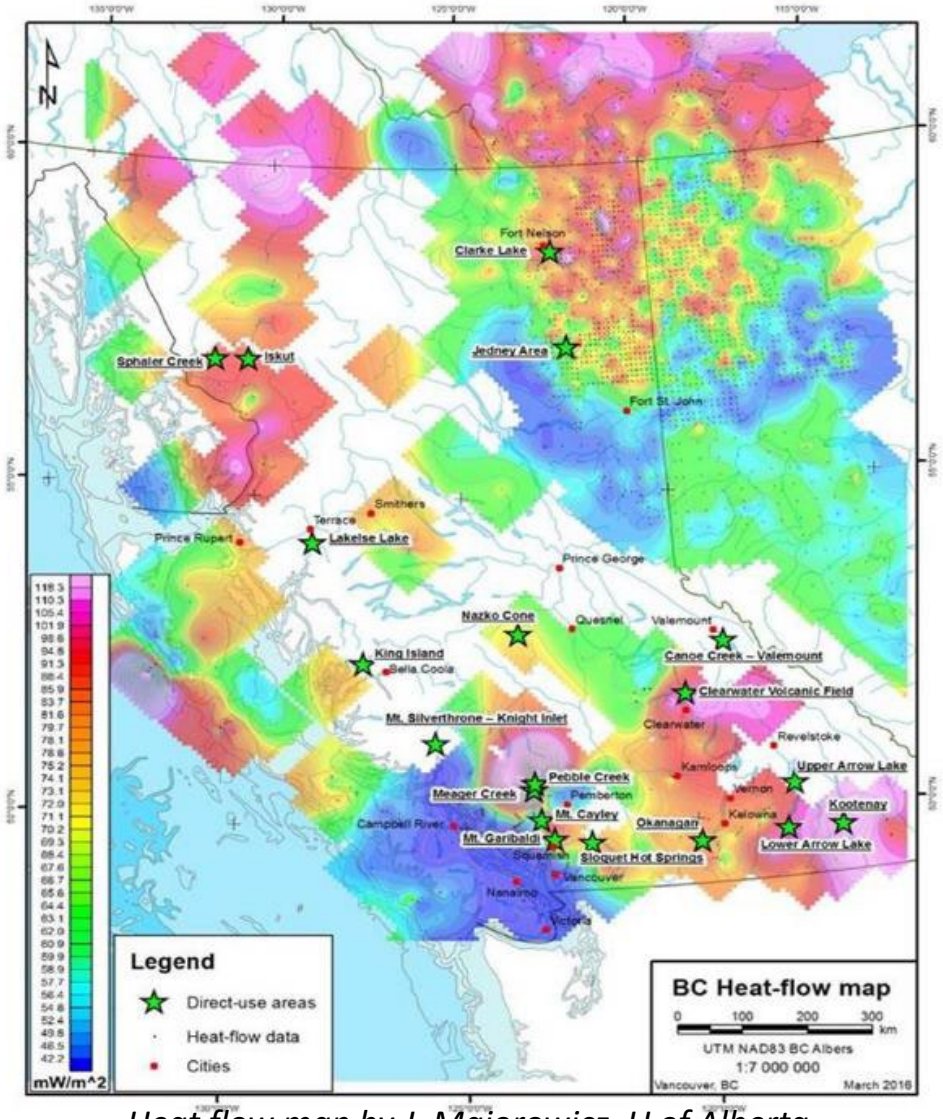
Where are the Geothermal Resources in British Columbia?

High temperature resources near the volcanic systems

Low to moderate temperature resources near deep faults and in the sedimentary basins

At least 63 communities have potential for geothermal resources

- Most communities not aware of direct-use applications
- Nor technologies for geothermal electrical generation at low to moderate temperatures
- Roadmap for development as a guide book for communities.



Heat flow map by J. Majorowicz, U of Alberta

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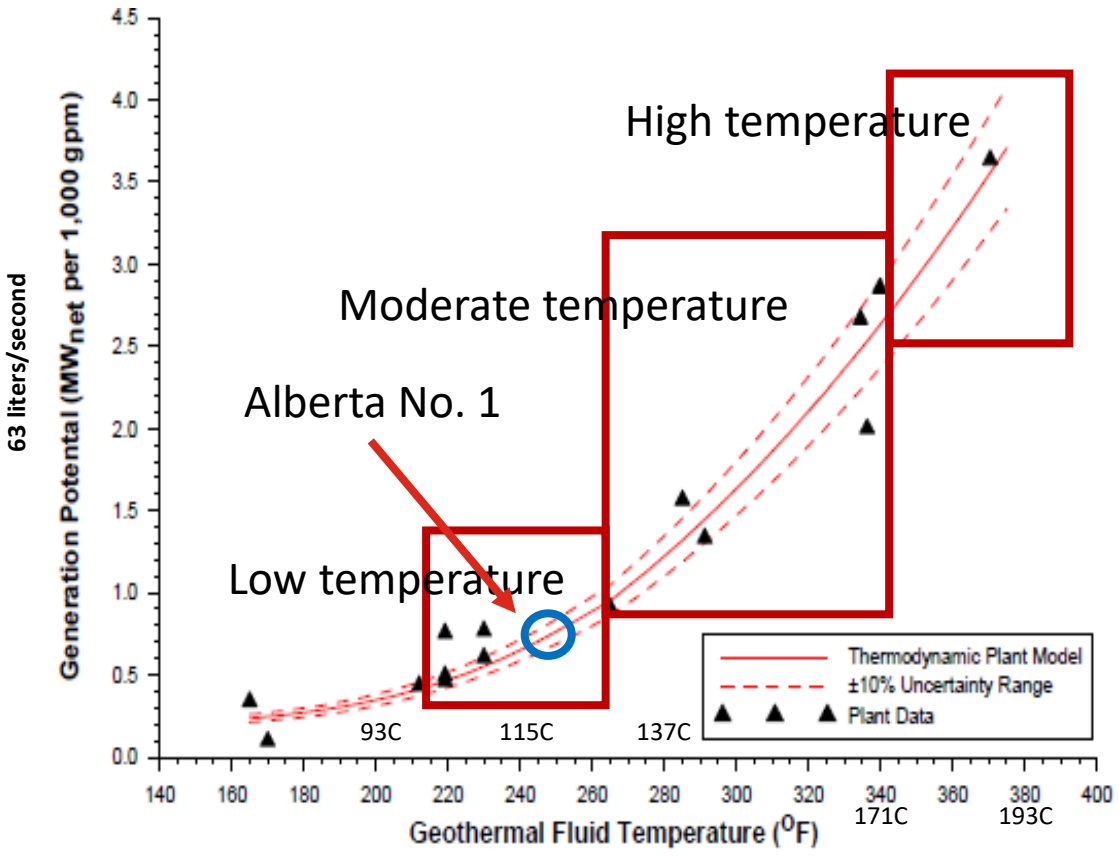
Geoscience BC

Alberta No. 1

Water Flow & Temperature

- Required volumetric flow rate necessitates wells with wider diameters than O&G
- 3 production wells and 2 injection wells planned



Generation potential vs. fluid temperature (Sanyal and Butler 2010).

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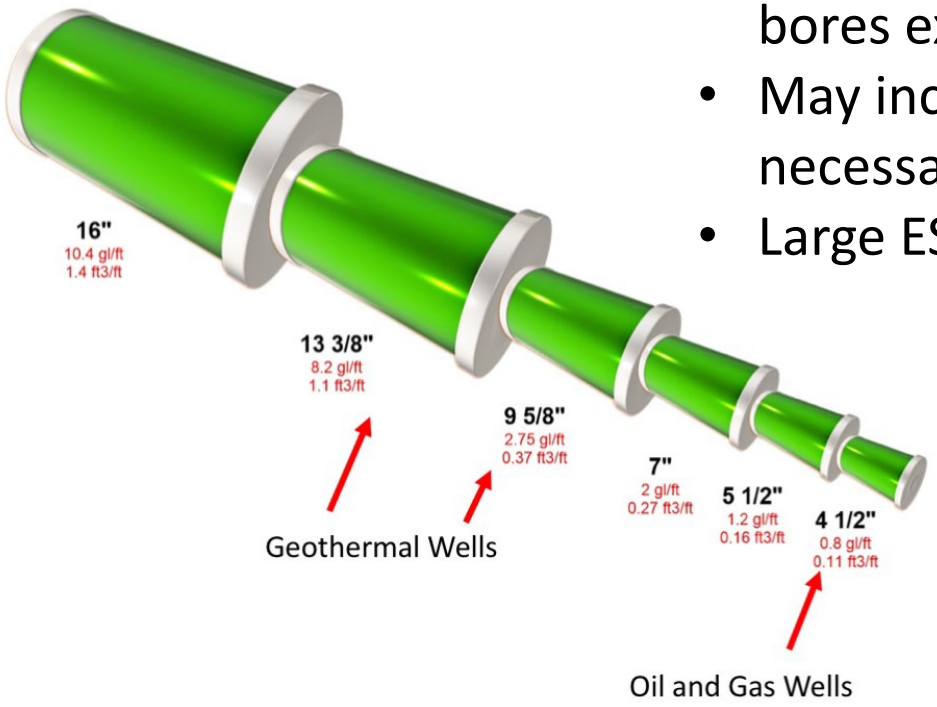
Pipe Sizing

- Required volumetric flow rate necessitates wells with wider diameters than O&G
- Estimated requirement for Alberta No. 1 is 300 liters per second or 4,755 gallons per minute



- Exploration & production/injection well bores expected to be 9 5/8“
- May increase to 13 3/8" if necessary
- Large ESP pumps required

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terrapin Heat Value Energy

Alberta No. 1

Geothermal Production Wells And Oil And Gas Wells

Geothermal: wide diameter; large well bore to accommodate deep set, large capacity pump; volumes of pumped fluids >> 30 l/sec.

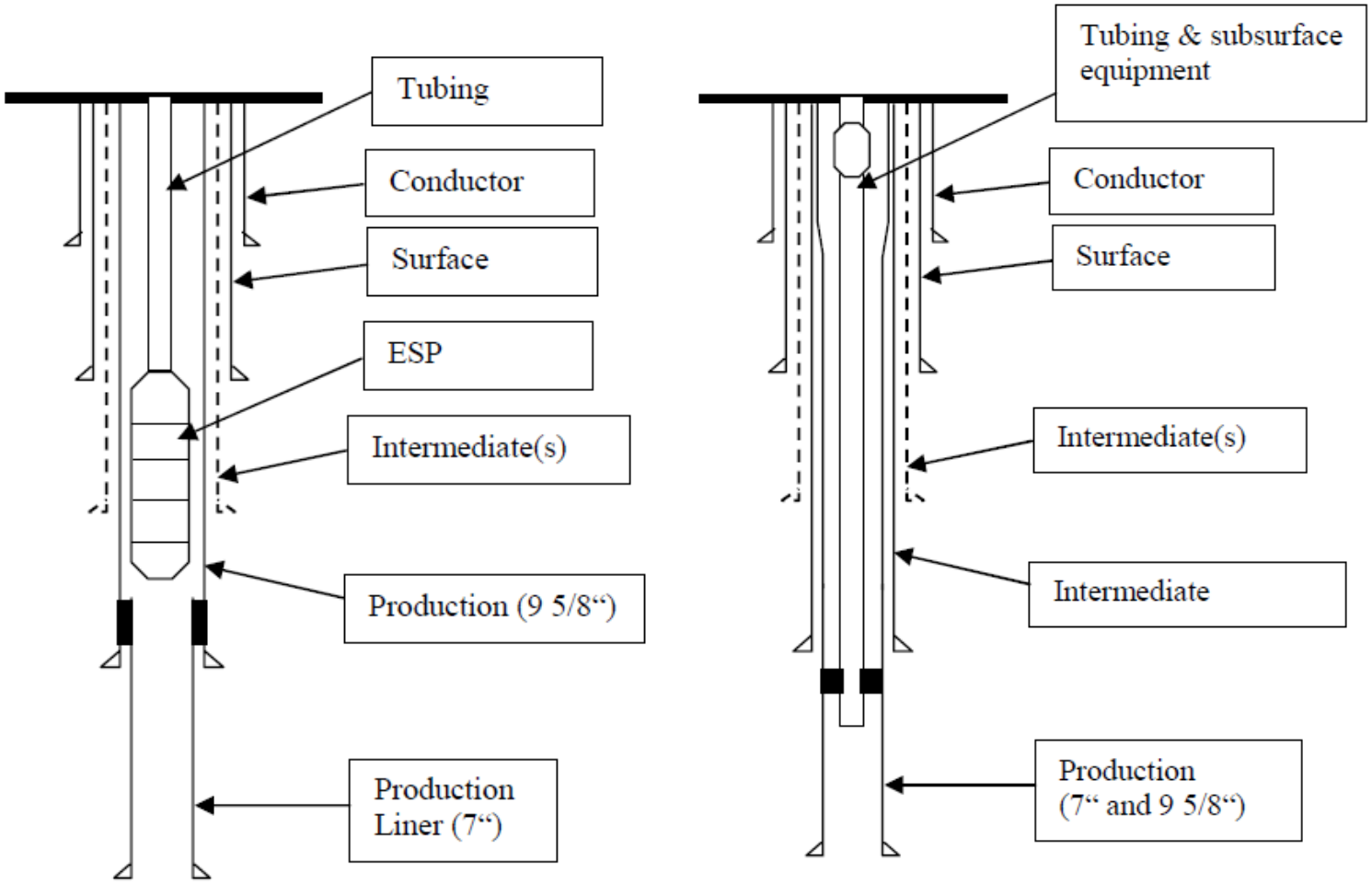

Figure: Teodoriu and Falcone (2008)

Oil and Gas: narrow diameters; shallow, small pumps; small diameter tubing often to depth.; volumes of pumped fluids < 30 l/sec.

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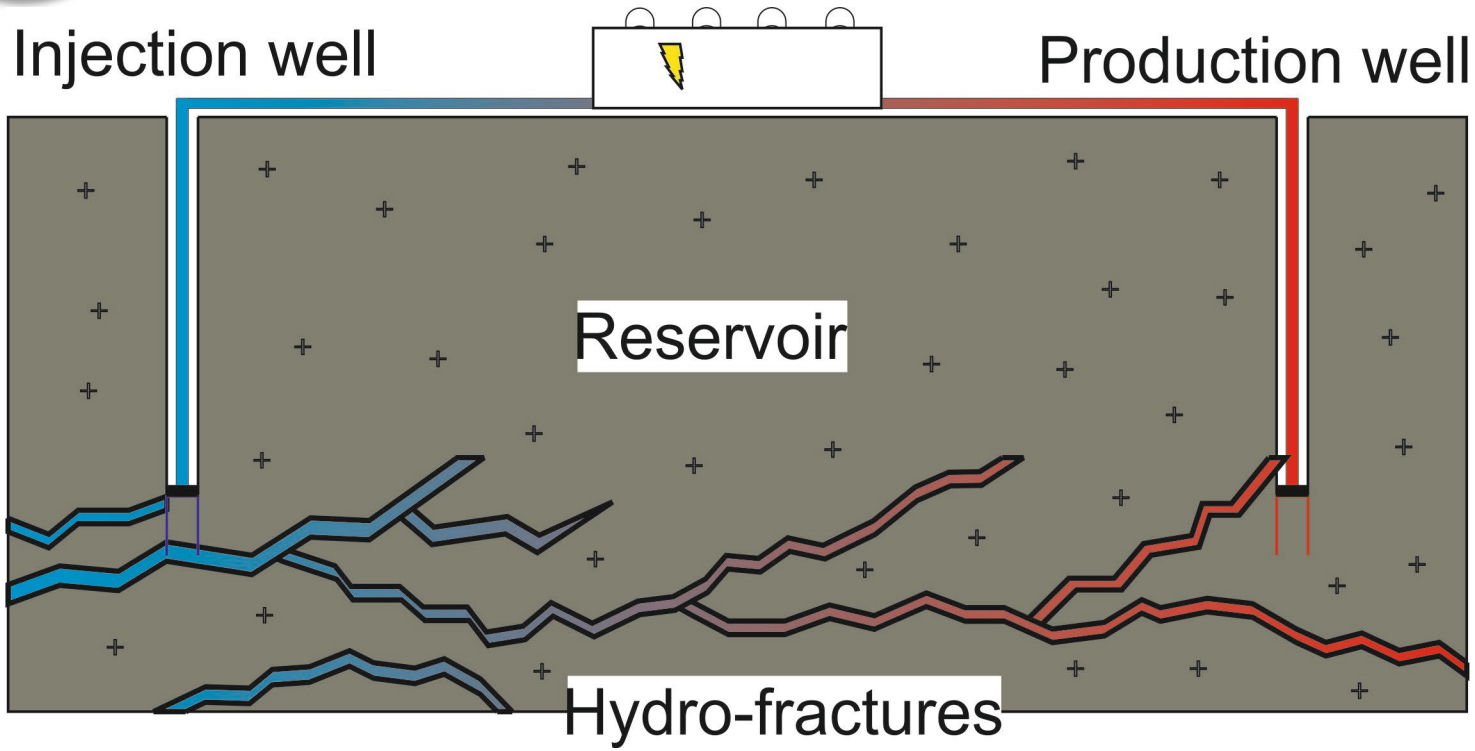
Are deep geothermal resources a viable alternative solution to produce heat for northern communities of Alberta? What about locations in the Canadian Shield?

INNOVATION AND COMBINATIONS!

Enhanced Geothermal Systems



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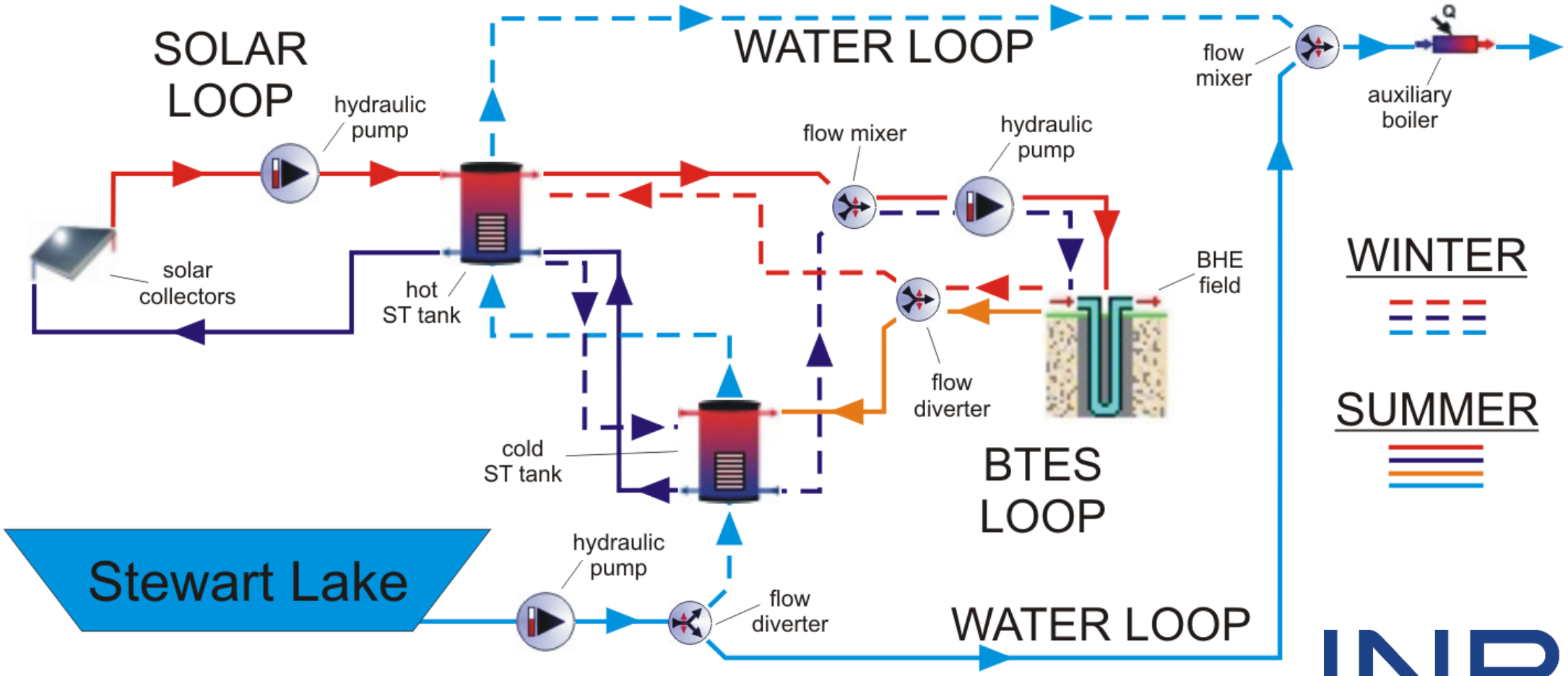
INNOVATION AND COMBINATIONS!



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Oil & Gas influenced technical advancement

- Drilling technology
- Expertise in sedimentary basins
- Well integrity
- Reservoir modeling and testing
- Directional drilling

DEEP | EARTH | ENERGY | PRODUCTION

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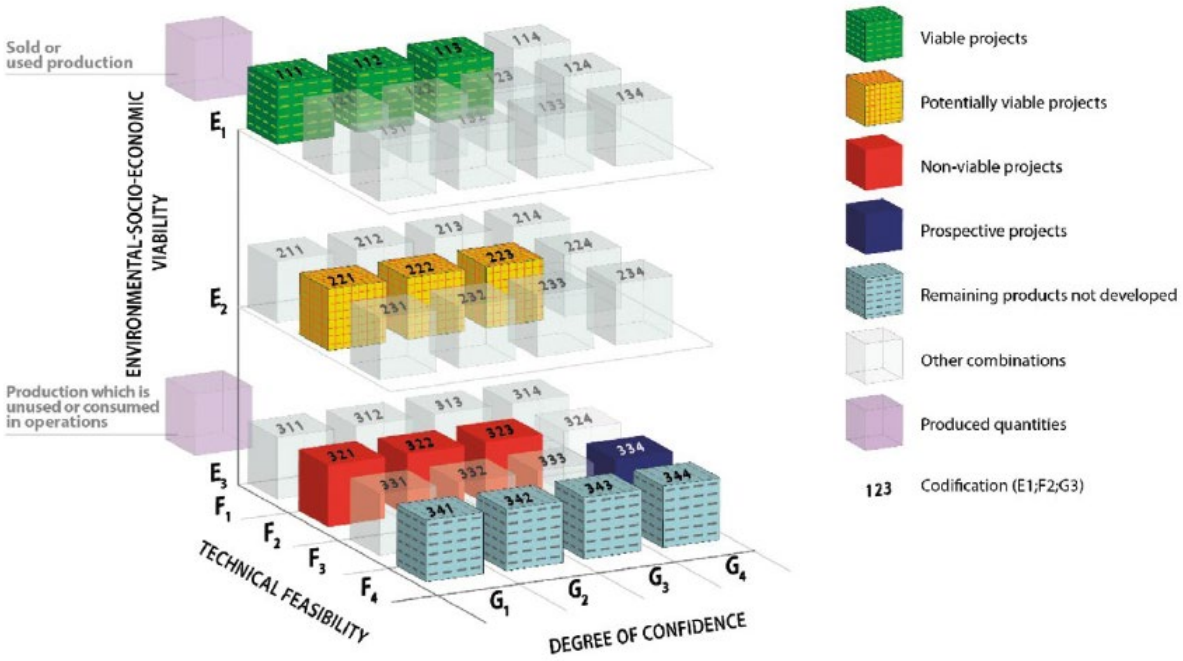
Resource estimations

United Nations Economic Commission for Europe (UNECE) have been developing a framework classification for all resources including geothermal energy. The importance of this update is its full alignment with the UN's sustainable resource management goals, referred to as '2030 Agenda for Sustainable Management'.



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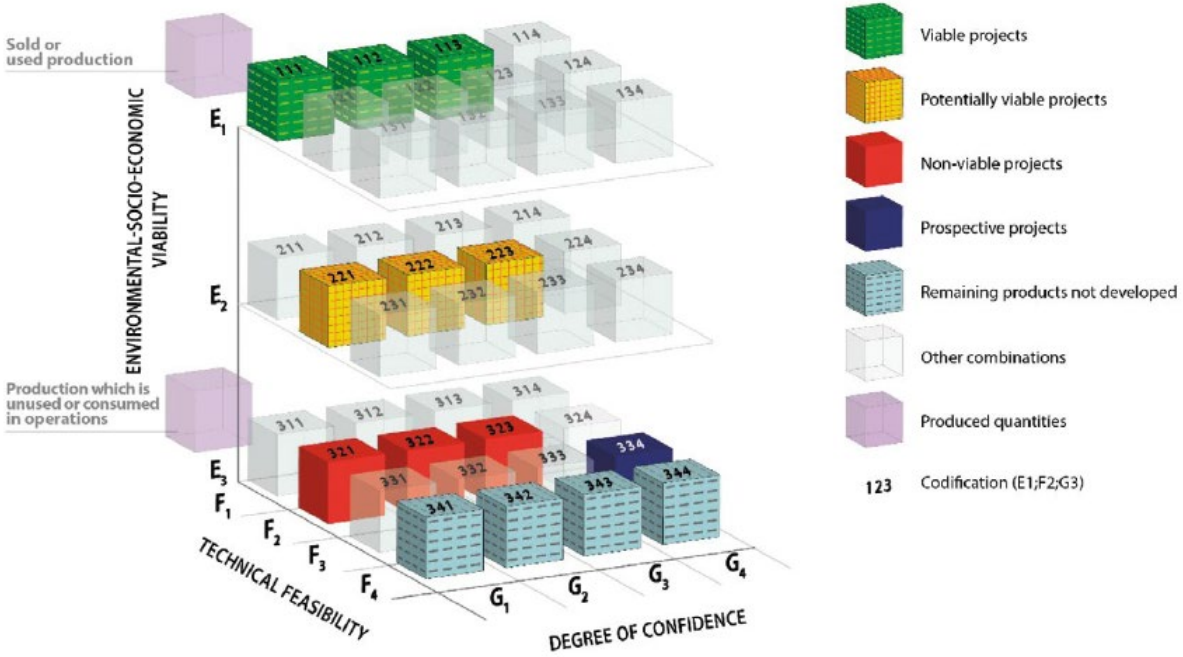
Resource estimations

This updated framework replaces the Australian and Canadian geothermal reporting codes which are voluntary codes. These codes were developed and released in 2010. As more companies investigate the geothermal potential of Canada, a reporting code similar to the NI43-101 and 51-101 will be useful for companies seeking to raise money through public funding.



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THANKS!!

Government help leading the way to kick start and industry

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