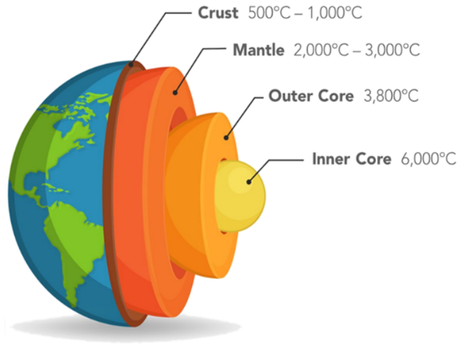
GEOTHERMAL 101

GEOTHERMAL CANADA

www.geothermalcanada.org

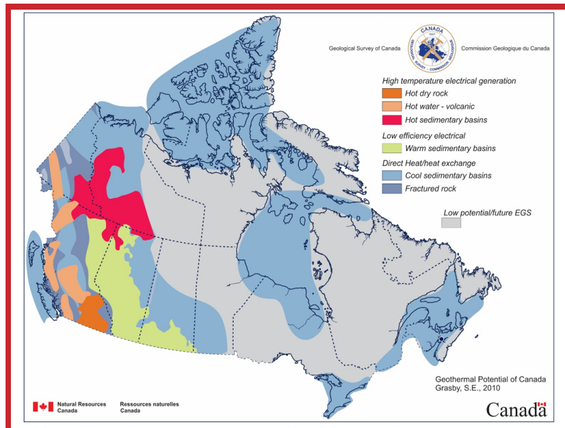


Geothermal heat is generated by the radioactive decay of elements in the upper crust (83%), as well as primordial heat from the formation of the planet (17%). Temperature increases with depth.

Reservoir Type	
1	Convective Hydrothermal Resources
2	Vapor Dominated
3	Hot-water Dominated
4	Other Hydrothermal Resources
5	Sedimentary Basin
6	Geopressured
7	Radiogenic
8	Hot Rock Resources
9	Solidified (Hot Dry Rock)
10	Part/Still Molten (Magma)

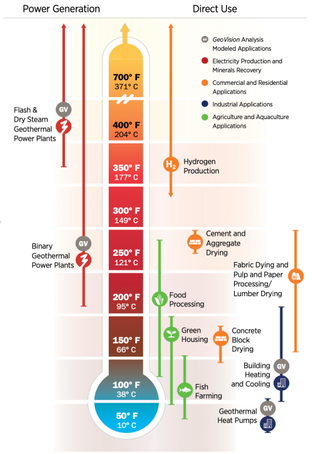
There are various types of geothermal resources. **Canada** has potential for all geothermal resource types with uses from low to high temperatures.

Reservoir Temperature	Reservoir Fluid	Common Use	Technology Commonly Chosen
High Temperature >170°	Fluid and/or Steam	Power Generation Direct Use	Flash Steam Combined (flash and binary) Cycle Direct Fluid Use Heat Exchangers Heat Pumps
Intermediate Temperature 110-170°C	Fluid	Power Generation Direct Use	Binary Cycle Direct Fluid Use Heat Exchangers Heat Pumps
Intermediate Temperature 70-110°C	Fluid	Direct Use	Direct Fluid Use Heat Exchangers Heat Pumps
Low Temperature 30-70°C	Fluid	Direct Use	Direct Fluid Use Heat Exchangers Heat Pumps

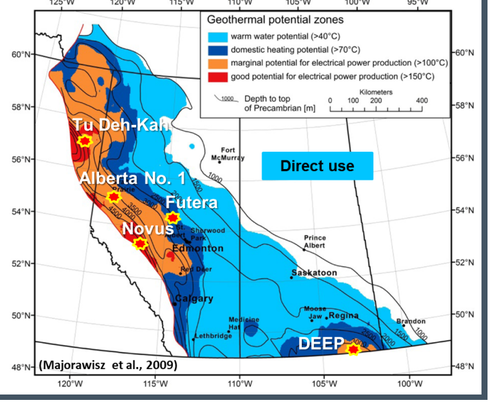


Map of geothermal potential in Canada based on end use.
Grasby et al. 2011

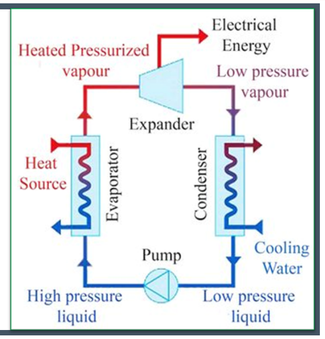
Canada's geothermal potential exists in sedimentary basins, volcanic systems and other hot dry rocks. Sedimentary basins can provide heat for direct use and electricity via Organic Rankine Cycle (ORC) generators. The volcanic and igneous systems of Western Canada offer the potential for high efficiency power generation through flash and dry steam generators. With advancing technology, Canada's geothermal energy potential will continue to grow.



Current geothermal projects underway in the Western Canada Sedimentary Basin, that will generate electricity and thermal energy.



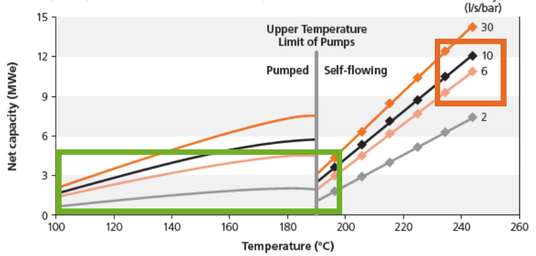
Thermal energy is extracted from the fluid to produce power through a binary **Organic Rankine Cycle (ORC)** system to create clean electricity. After the ORC, the still hot fluid goes through a heat exchanger to extract heat for district and/or industrial heating. Once all the energy is extracted, the fluid is reinjected into the Earth to be reheated and used again on multi-decadal or longer timeframe.



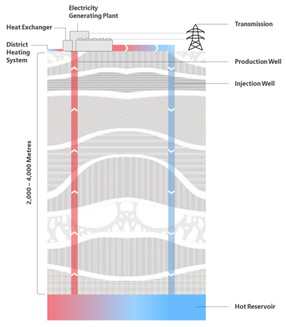
Geothermal Energy - the Solution.

- **Lowest land use footprint per MW of all renewable energy.**
- **Baseload (24/7 – 365) capabilities and available on demand (dispatchable) and lasts more than 40 years.**
- **Most prevalent baseload renewable resource (heat & electricity) in many jurisdictions and excellent Environmental, Societal, Governance (ESG) values.**
- **Most effective renewable for Green House Gas (GHG) reductions & lowest environmental footprint of all renewables.**
- **Dual commodity value (heat & electricity) plus "add-ons" such mineral extraction and CO_2 sequestration.**
- **In areas with existing hydrocarbon industry, geothermal utilizes oil and gas assets, expertise and data.**

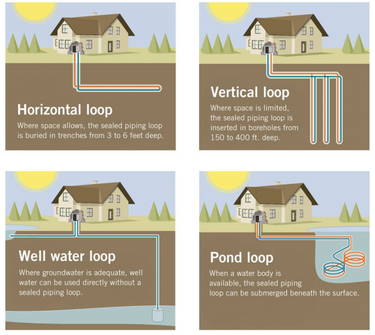
Net capacity (MWe) of a well vs. temperature



Net power capacity of a geothermal well vs. the temperature of pumped or self flowing wells. Canada's geothermal power potential for sedimentary basins is outlined in green, and the potential for volcanic / igneous systems is outlined in orange.



An example of a **Conventional Geothermal** well pair generating power and thermal energy. Wells are typically drilled to depths greater than 1 km. They generate large thermal outputs even at lower temperatures with high fluid volumes. These geothermal systems are sustainable over decades with good management.



Geoexchange® systems use heat pumps to recover and store heat from various sources, in the ground. Heat pumps extract atmospheric heat during summer months, storing it for extraction during the winter. Heat exchange systems can also use groundwater or surface water as the thermal storage mechanism or even the heat transfer mechanism.

Enhanced (Engineered and/or Advanced) Geothermal Systems (EGS) are man-made geothermal reservoirs created by injecting fluid from surface to increase permeability in existing hot rocks. These emerging technologies would allow for geothermal power to be generated anywhere with hot rocks. including the Canadian Shield, as shown on the map.