



Geothermal: *Heating Up* Rural Economic Development

Economic Development Division: Webinar Series

Ministry of Jobs, Tourism and Skills Training

February 28, 2017

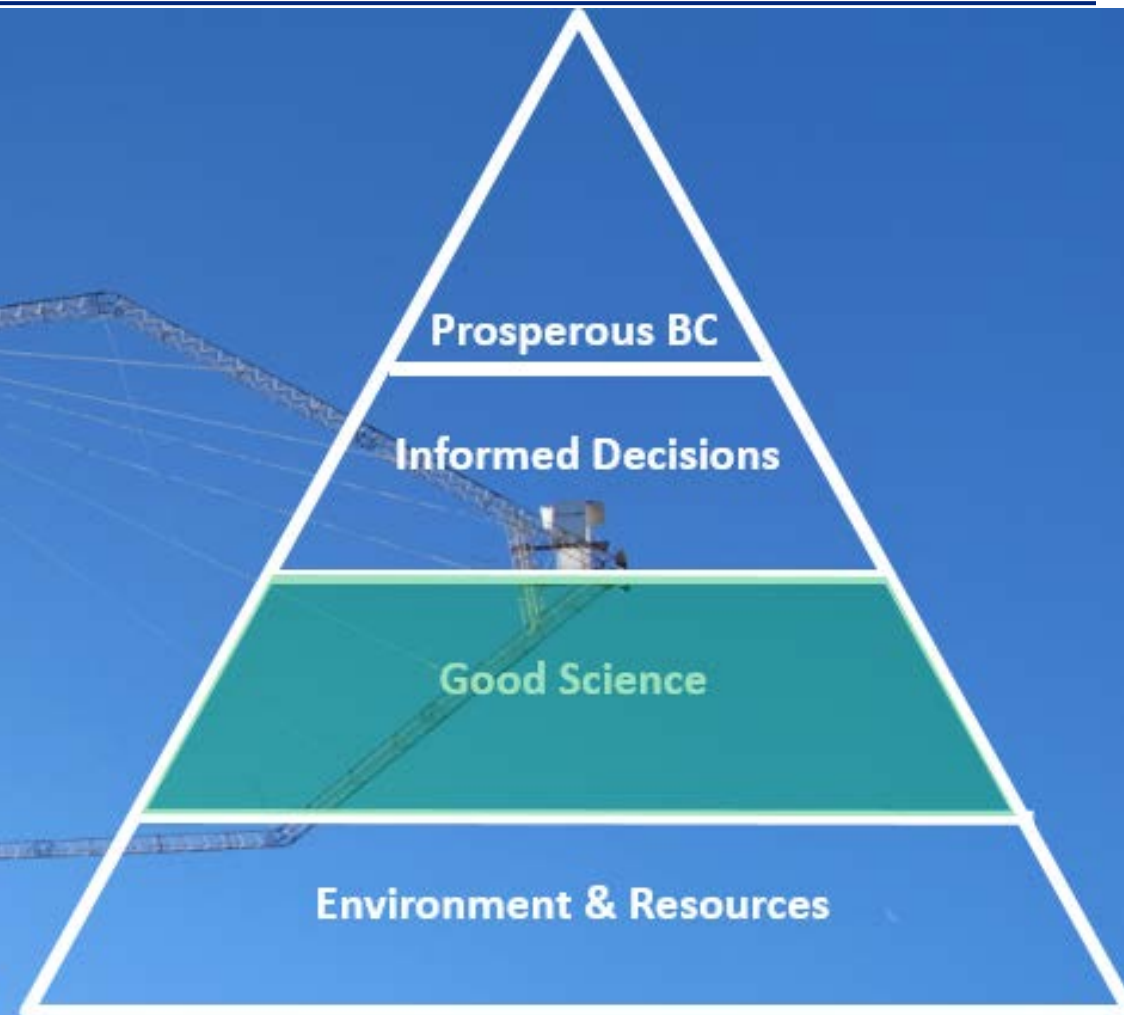
“Our earth science attracts investment that creates jobs and enables informed resource management decisions”

- *NGO, publically-funded and we leverage our funding through partners*
- *We look to infill “knowledge gaps”*
- *All information is made freely available to the public*
- *www.geosciencebc.com*

Technical Advisory Committee

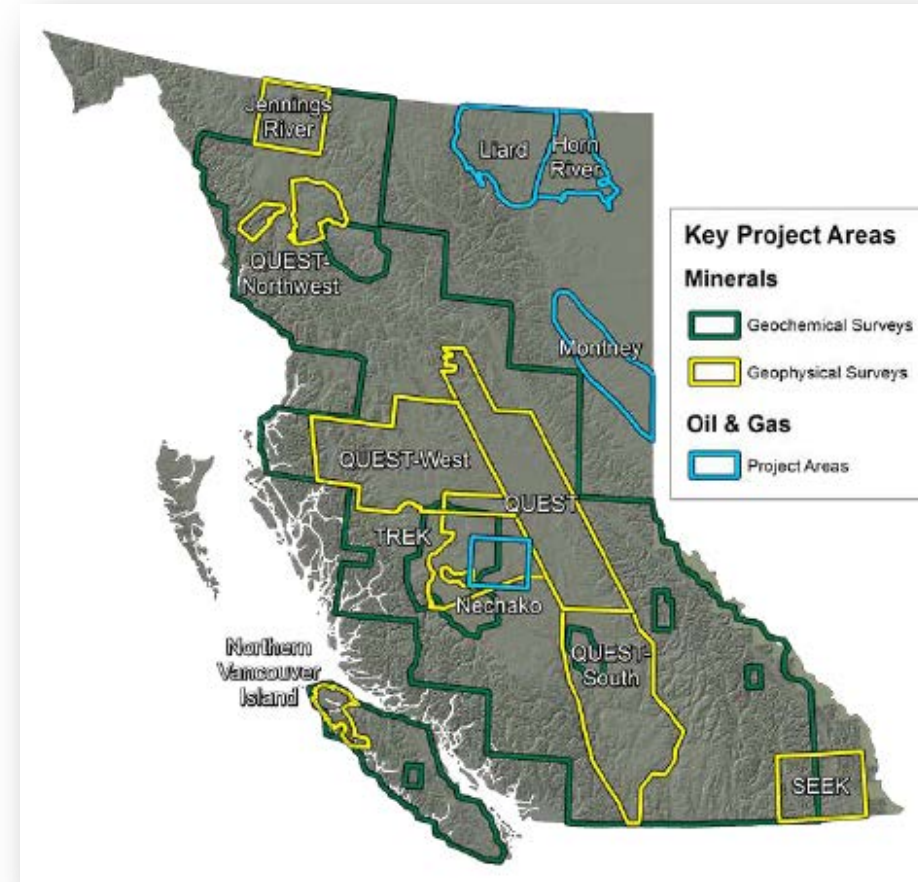
- Dr. Grant Ferguson (U. of Sask.)
- Dr. Steve Grasby (GSC)
- Sarah Kimball (BGC Engineering)
- Dr. Jasmin Raymond (INRS-ETE)
- Tim Sadlier-Brown (consultant)
- Dr. Nathalie Vigouroux-Caillibot (Douglas College/SFU)
- Warren Walsh (MEM)
- Dr. Jeff Witter (Innovate Geothermal/SFU)
- Dr. David Chapman (University of Utah)

Unbiased
Guided by experts
collaborative solutions



A Decade of Earth Science for BC

- Over 50% of province covered by Geoscience BC projects since 2005
- Mineral exploration & mining
- Energy projects
 - Oil & Gas
 - **Geothermal**

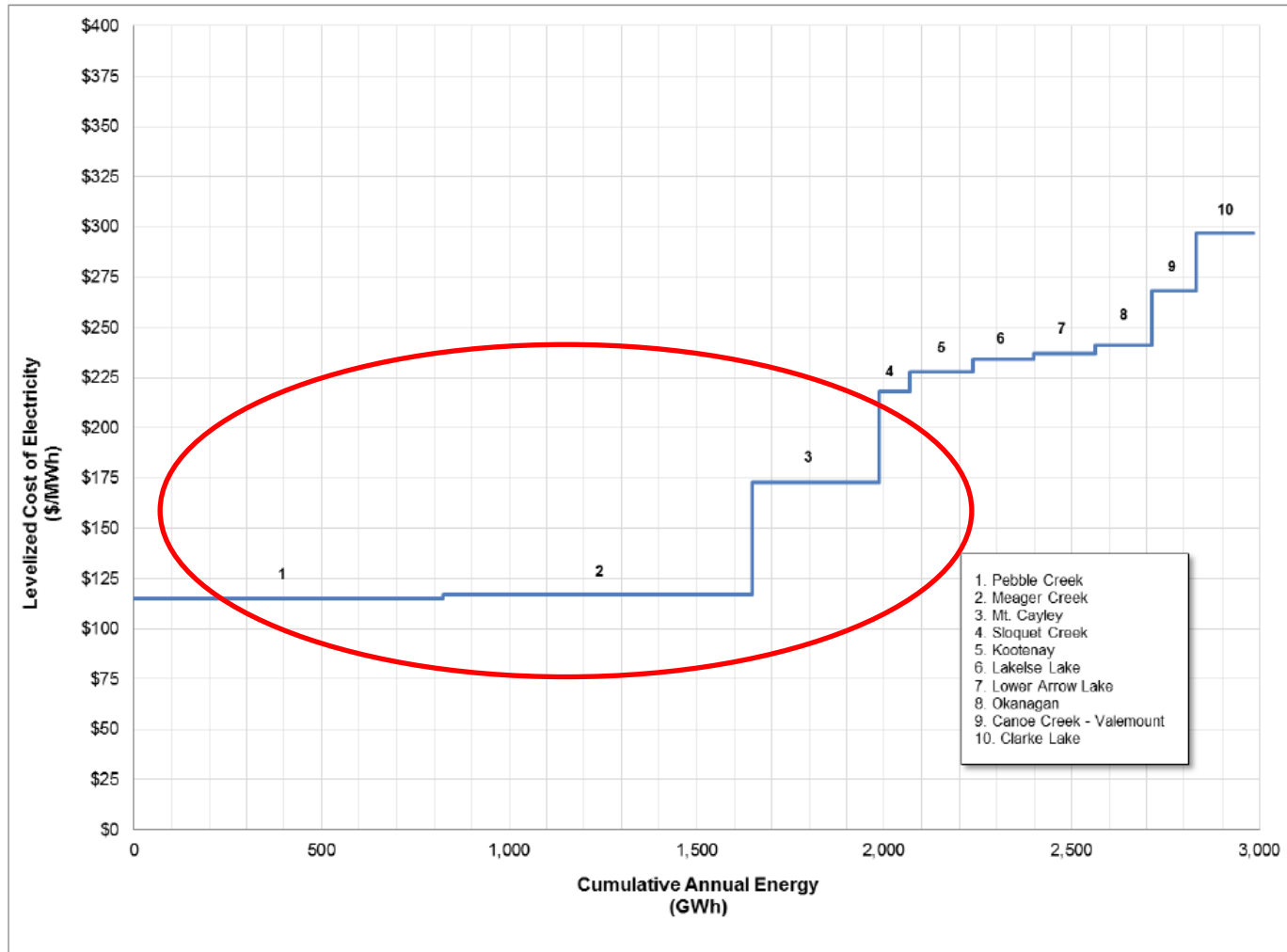


An Assessment of the Economic Viability of Selected Geothermal Resources in British Columbia (Kerr Wood Leidal & Geothermex)

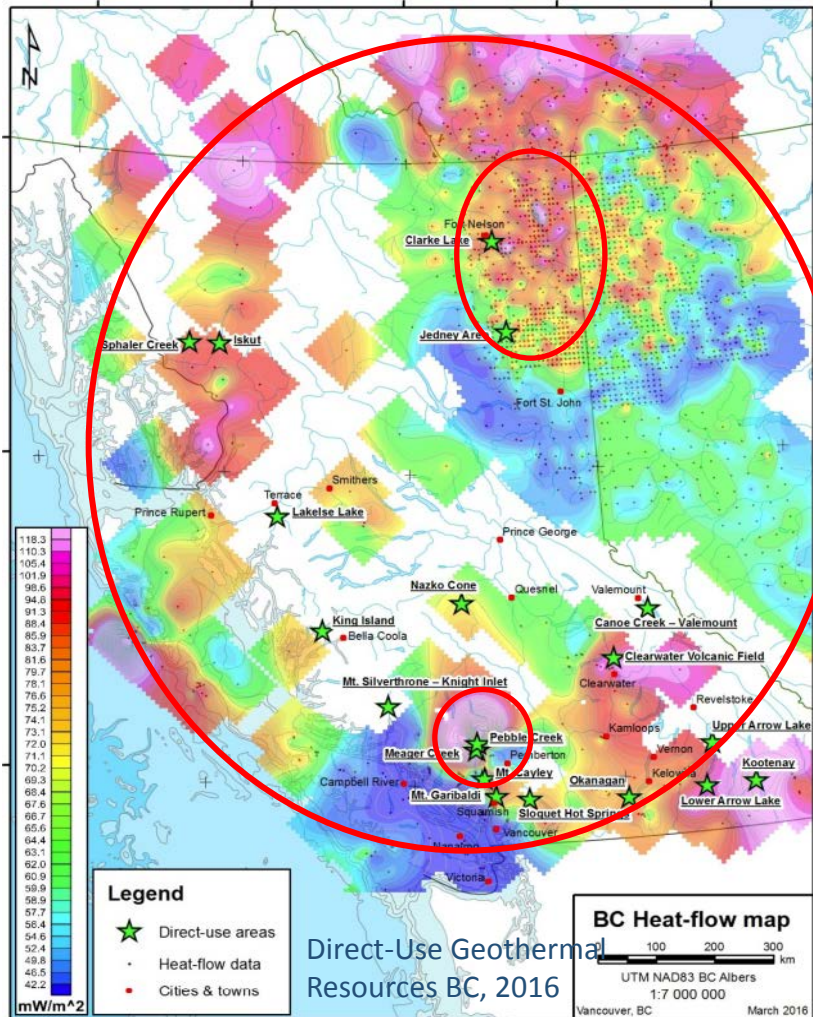
- 18 sites picked
- 10 of the most “favourable” sites had economics run
- Objective
 - high-level look at which sites were economically viable for electrical generation
 - Where to follow-up with future projects



Geothermal: *Heating Up* Rural Economic Development



- The 3 sites within the Garibaldi Volcanic Belt the most prospective of the 10 sites
- assumptions on capital costs can make costs of energy vary materially



This helped guide follow-up projects...

1. **Regional Heat flow mapping**
 - Curie Point Depth Mapping Pilot Study
2. **NEBC- The Western Canada Sedimentary Basin**
 - A closer look
 - Kevin Palmer-Wilson et al.
 - Jonathan Banks
3. **Garibaldi Volcanic Belt**
 - Economically interesting
 - Close to a market which will need capacity
 - Future work
4. **Direct-use: Economic Development**
 - Dr. Cathie Hickson et al. study



Direct-use Geothermal Resources in BC

Our independent earth science enables informed resource management decisions and attracts investment that creates jobs

Dr. Catherine Hickson, P.Geol.
Yuliana Proenza, P.Geol.

BC Economic Development Division Webinar
Winter 2017

PRESENTATION OVERVIEW

Geoscience BC Report

DIRECT-USE GEOTHERMAL ENERGY

- What is Geothermal
- Where is Geothermal
- Why Geothermal in BC

Barriers to Geothermal

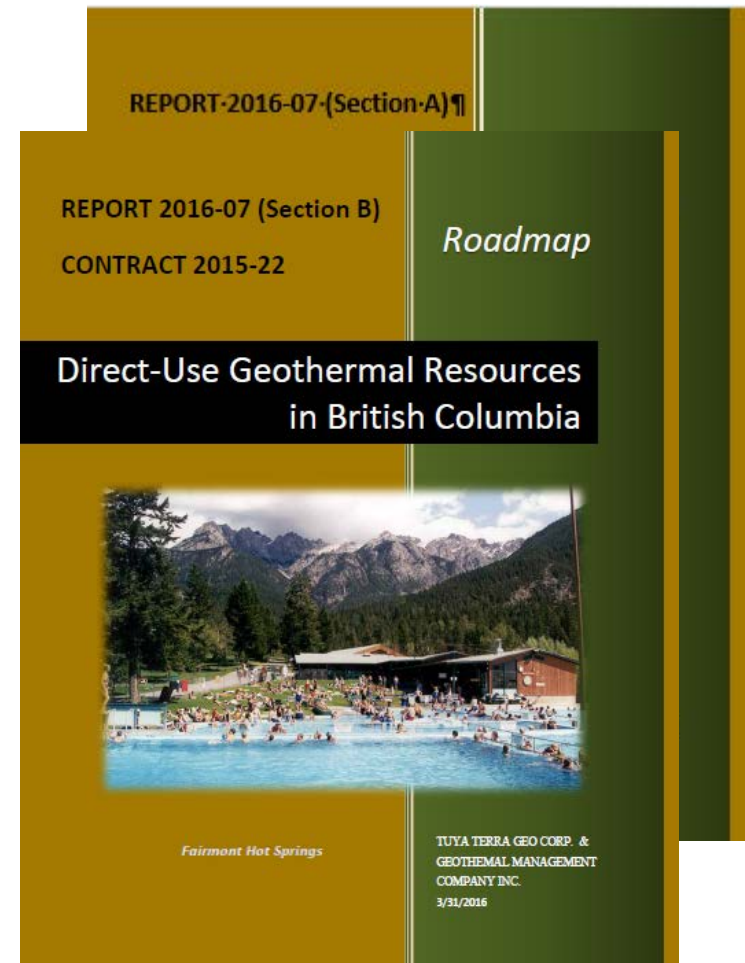
Access to Funding for Communities

BC Geothermal Case Studies

Current Developments – Case Studies

Resources

Suggested Steps for Communities



Geoscience BC Report Overview

Objective

- Identify and evaluate **Direct-use geothermal** energy opportunities for BC communities
- Report results available at <http://www.geosciencebc.com/s/Report2016-07.asp>

Section A

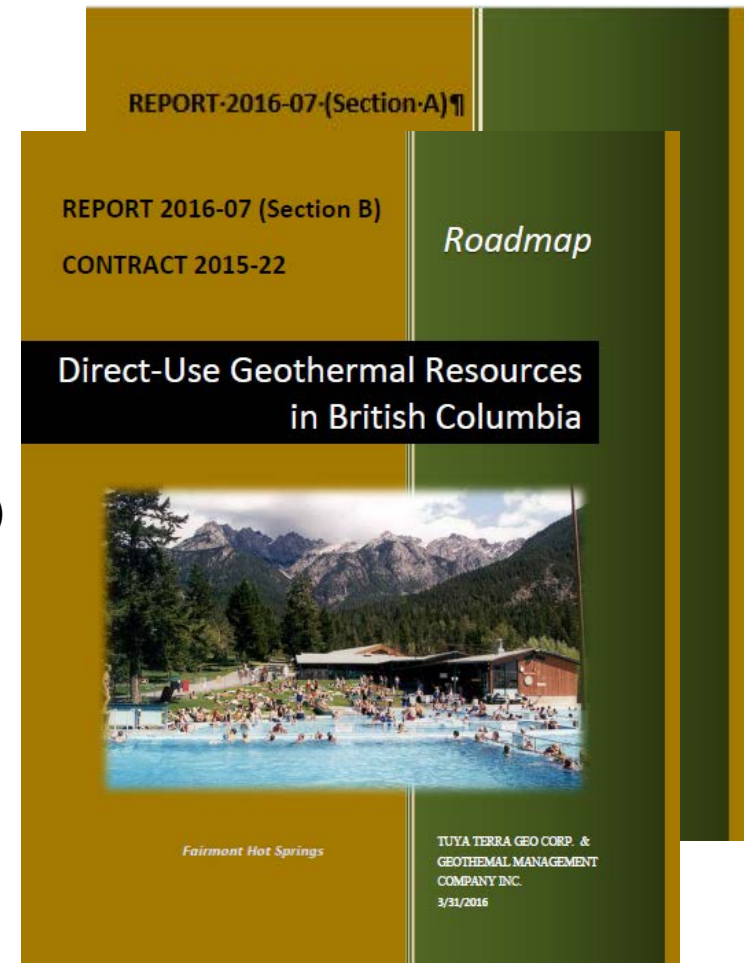
- Phase 1: data gathering
- Phase 2: community engagement and capacity building
- Phase 3: completing Geothermal Development Decision Matrix (GDDM) and completing the Roadmap (Section B)

Section B

- Technical Roadmap as a reference for communities interested in developing Direct-use heat applications

Follow up:

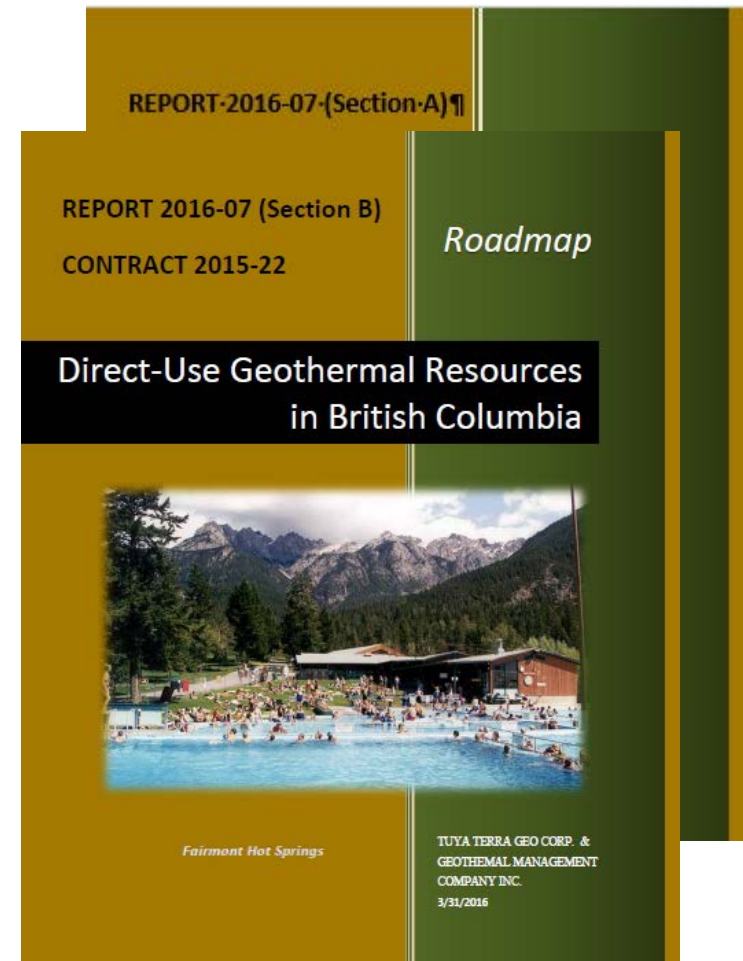
- Follow up/additional community engagement
- Reaching out to educational institutions
- Online webinars
- Online legacy of project: www.bcgeoheat.com



Geoscience BC Report Overview

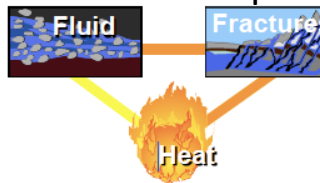
Target Audience

- Report results available at <http://www.geosciencebc.com/s/Report2016-07.asp>
- Economic Development Officers
- Planning Department
- Resource and Lands Department
- Building Inspector/Managers
- Sustainability Managers
- Energy Managers
- The general public (residential, commercial, industrial industries all require heat for various processes)



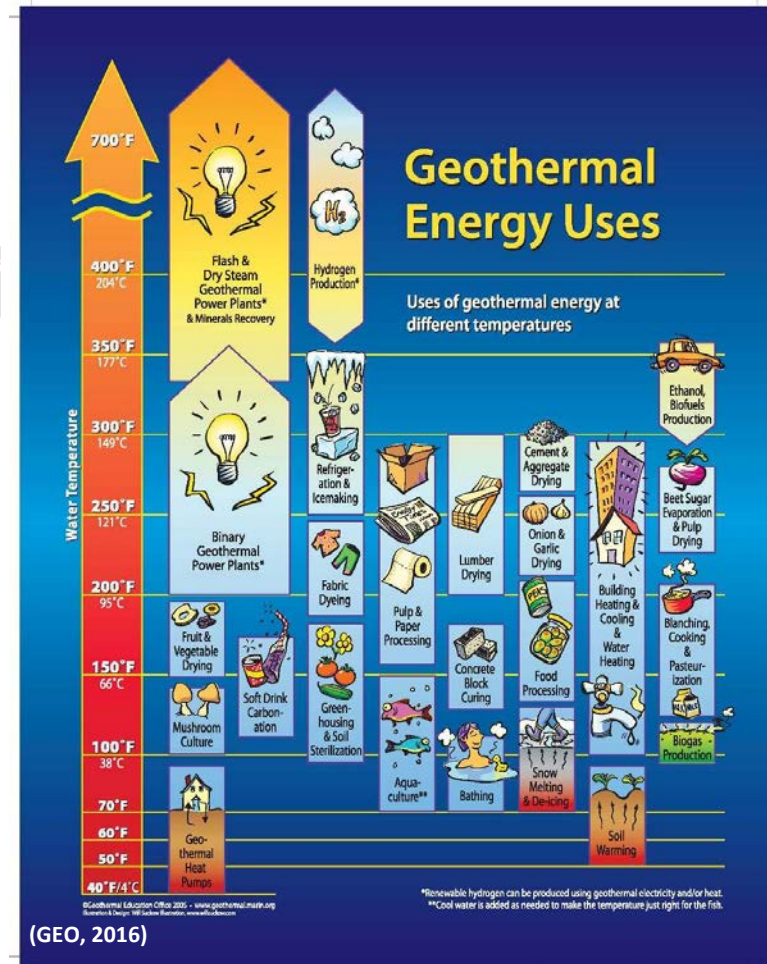
What is Geothermal?

- Naturally occurring and regenerating heat (**thermal**) derived from the earth (**geo**)
- Very deep heat resource is massive, but high temperatures are only found at accessible depth in a few special situations



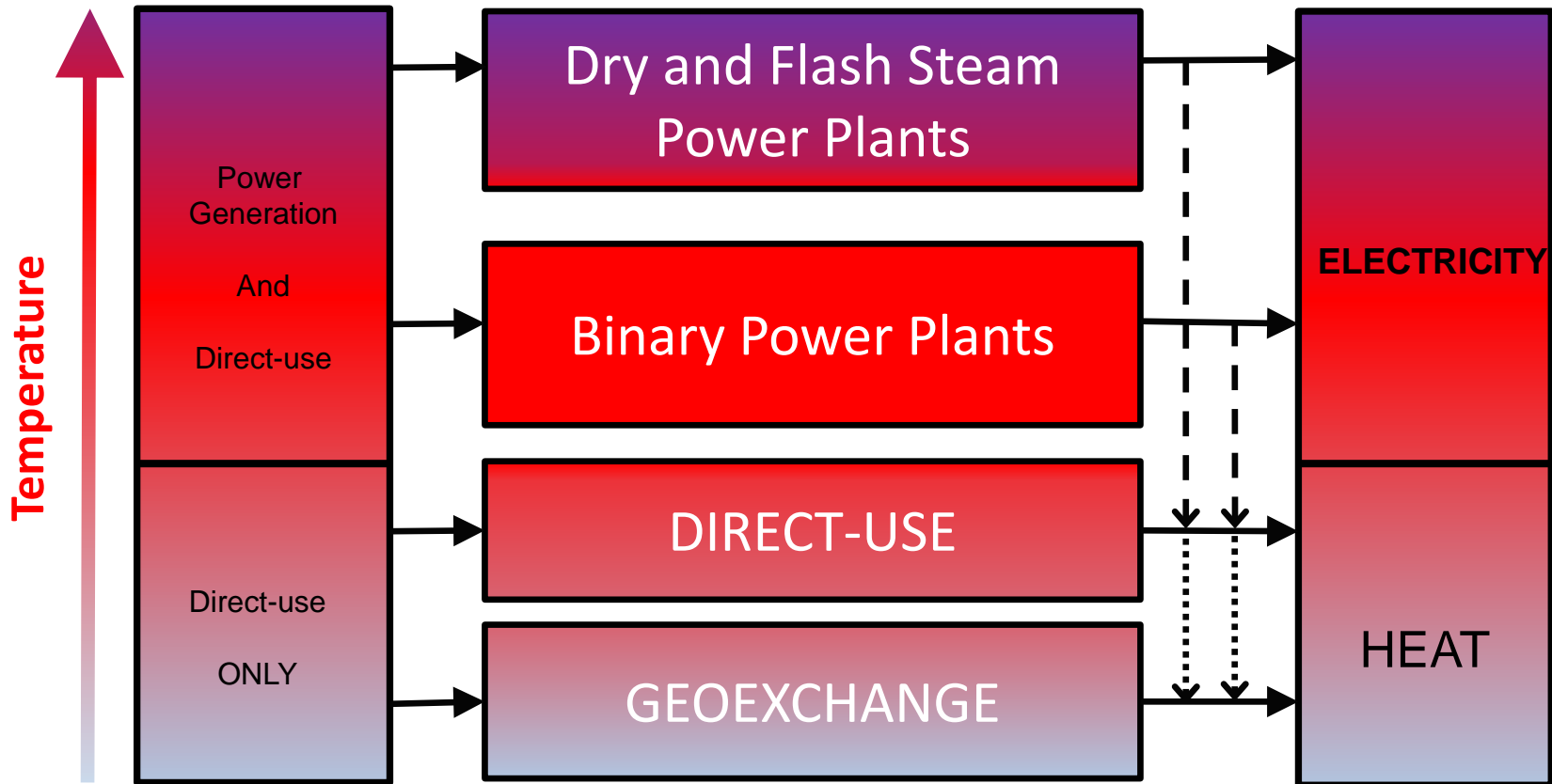
Mature technology – 3 levels of use

- **Power generation**
 - >100 year old technology
- **Direct-use applications**
 - Used culturally by indigenous peoples of the world for 1000's of years (ie. Sacred grounds, Bathing, cooking)
- **Geothermal heat pumps**
 - In use since the 1940's



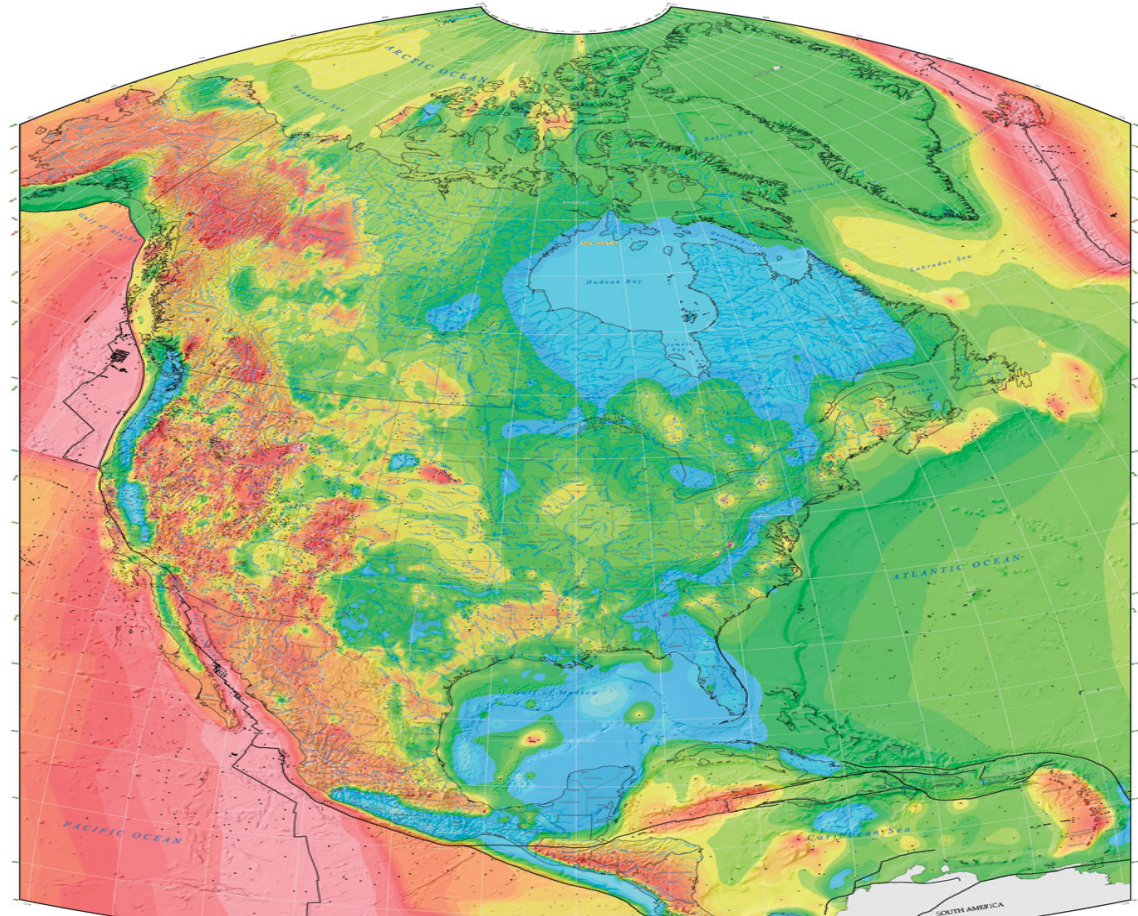
The Geothermal “Spectrum”

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



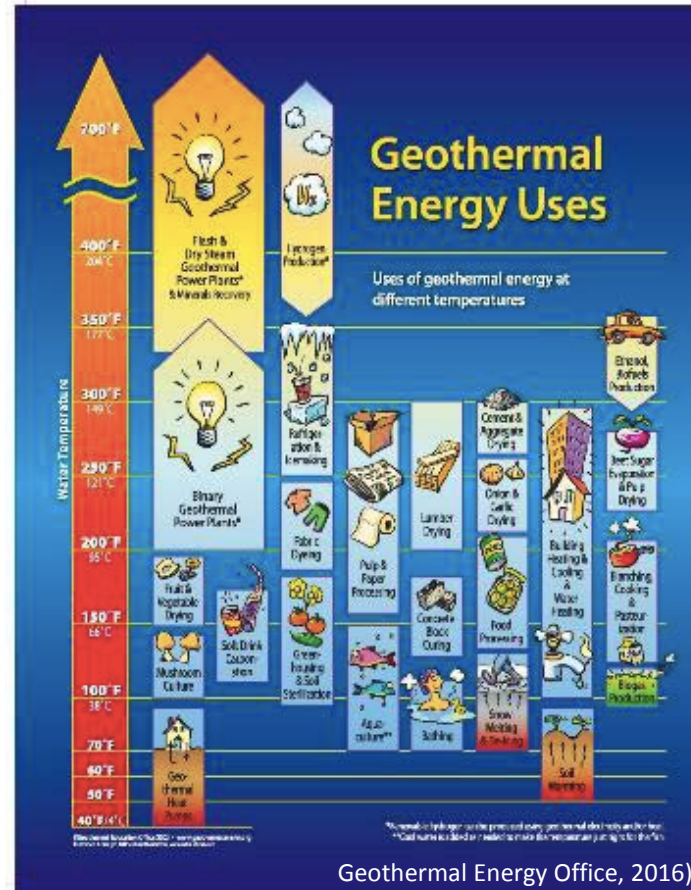
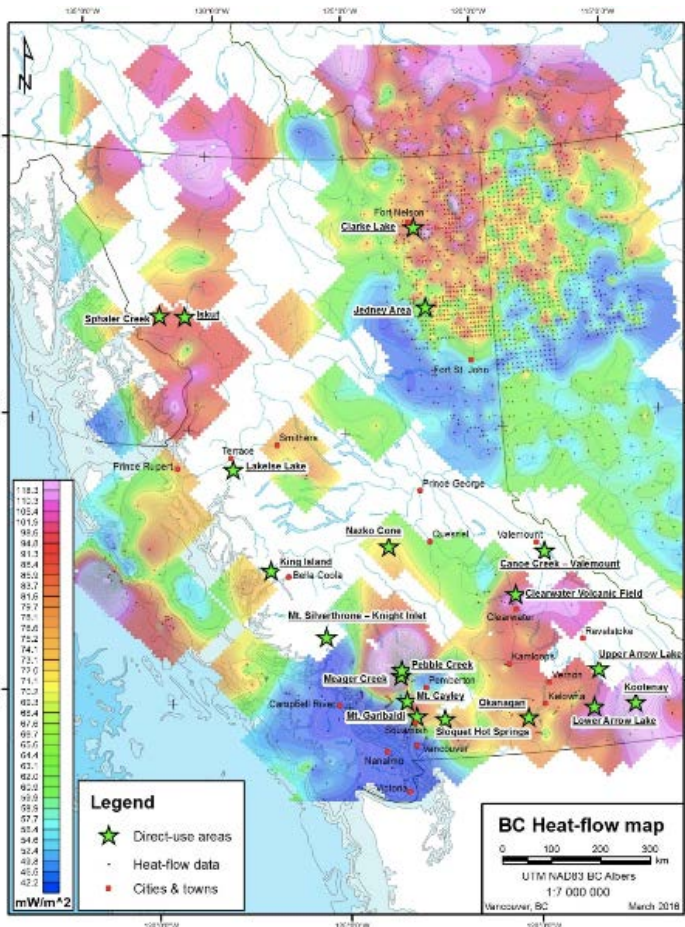
Where is Geothermal?

- Geothermal Power generated in Alaska, mainland US and Mexico
- Commercial hot springs and Geoexchange residential and district heating systems in BC → no power
- Opportunity for geothermal heat applications in BC:
 - Heating/cooling systems for residential, commercial, industrial processes
 - Aquaculture
 - greenhouses
 - Breweries/Wineries
 - Any process that requires heat



<http://www.geni.org/globalenergy/library/renewable-energy-resources/world/north-america/geo-north-america/indexbig.shtml>

Where is Geothermal in BC?



- High BC potential
- Heat flow map updated in 2016
- Electricity and Direct-use (heat)
- GeoExchange can be deployed BC wide on an individual unit scale or as district energy system

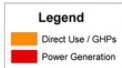
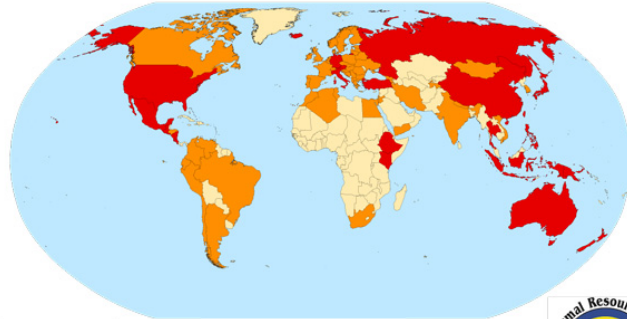
Where is Geothermal?

Global Growth of **Direct-use** Geothermal (2015)

- Canada is 5th in direct utilization of geothermal by energy used (TJ/year)
- 45% global growth since 2010
- Installed capacity 70,330 MWth across 82 countries
 - Up from 48,500 MWth 5 years ago
- Has helped offset 148 million tonnes of CO2 annually
- Slightly more than ½ of Direct-use geothermal applications globally comes from GeoExchange systems
- GeoExchange and Direct-use can work in synergy, increasing efficiency of system
- Significant increase in # of countries making use of Ground-Sourced Heat Pumps (GeoExchange), from 26 in 2010 to 48 in 2014

Where is Geothermal?

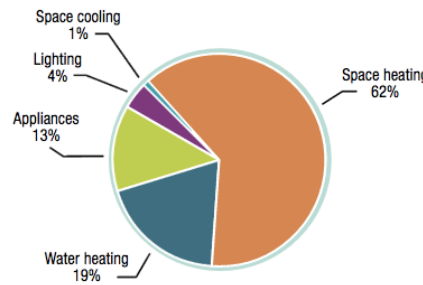
Global Geothermal Use



Based on 2010 data from the International Geothermal Association. Nearly all countries that produce geothermal electric power also utilize direct use and/or geothermal heat pumps.

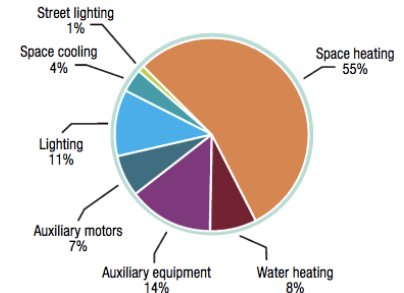


Energy use by end use, 2013

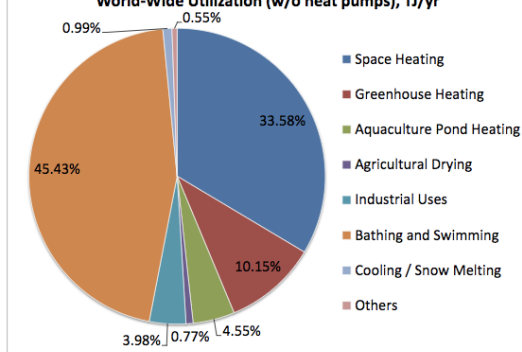


Energy use by end use, 2013

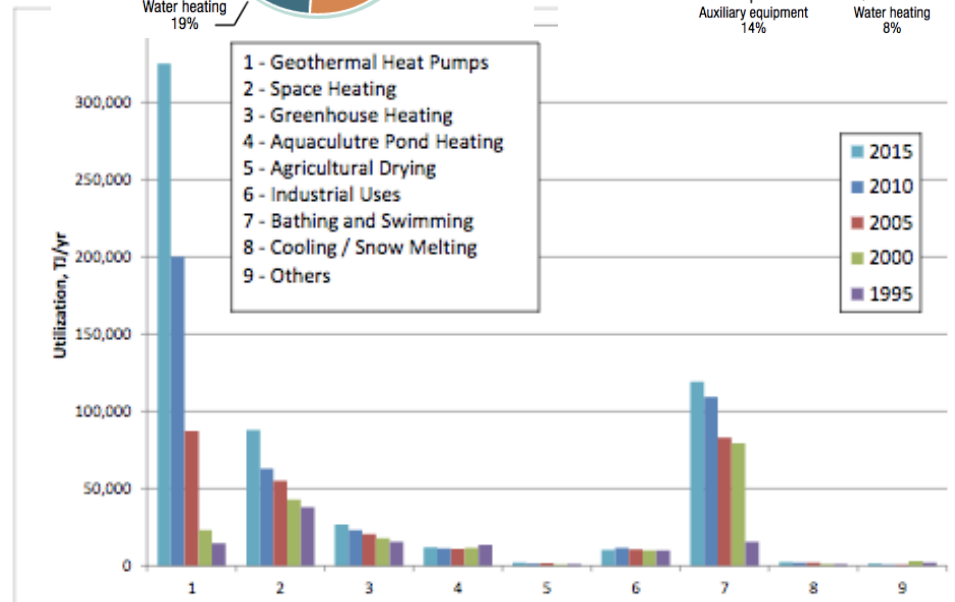
Source: NRCAN



World-Wide Utilization (w/o heat pumps), TJ/yr



Geothermal direct applications worldwide in 2015 without geothermal heat pumps, distributed by percentage of total energy used (TJ/yr)



Lund & Boyd, 2015

Comparison of worldwide direct-use geothermal energy in TJ/yr from 1995, 2000, 2005, 2010 and 2015.

Why Geothermal in BC?

ENERGY USE

- Can be used for any process that requires/rejects heat (ie. Space heating/cooling, greenhouses, aquaculture, breweries, wineries, etc)
- Direct-use geothermal extracts heat from warm groundwater
- GeoExchange (geothermal heat pumps) utilizes the constant ground temperature found at several metres depth

ECONOMIC DEVELOPMENT

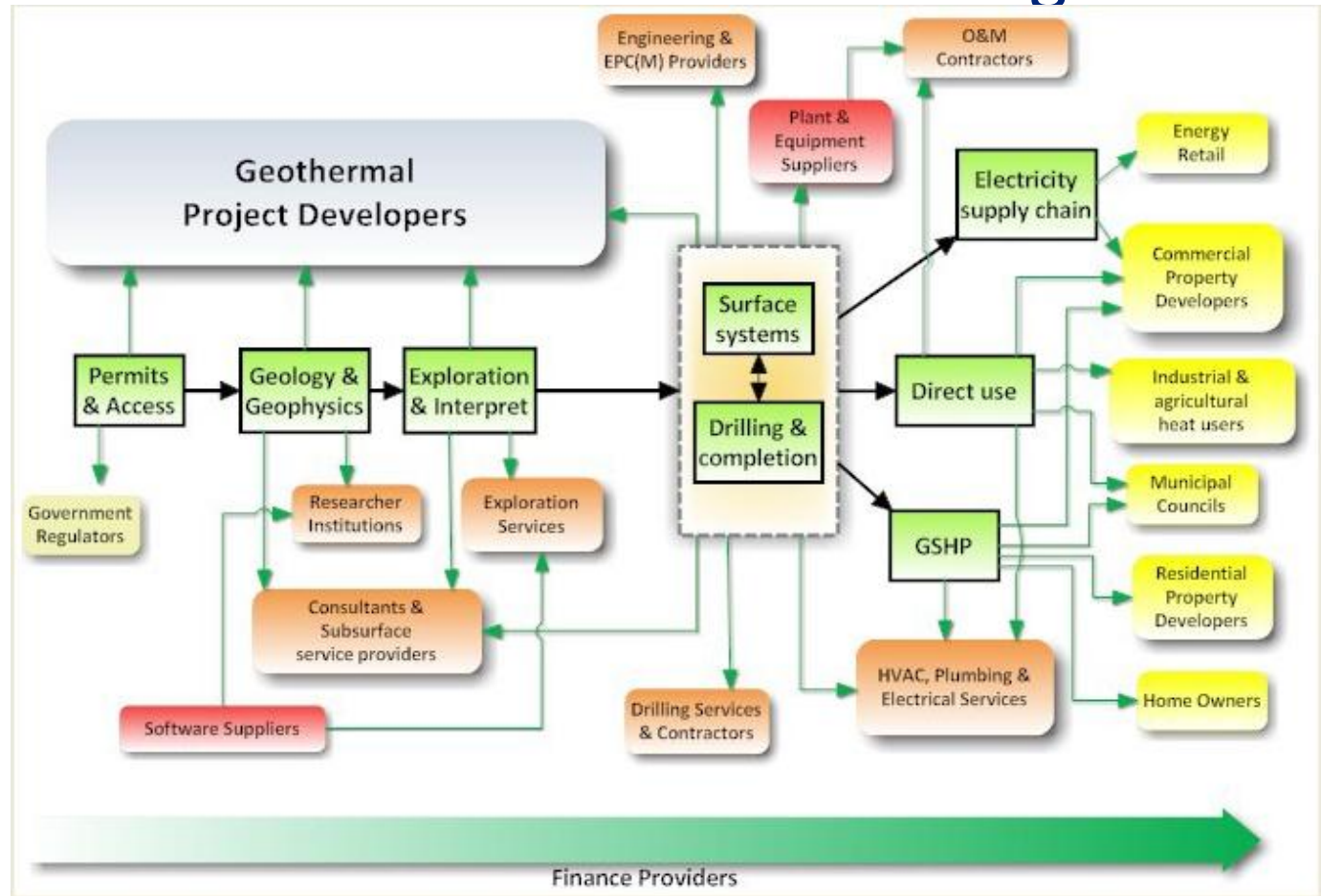
- Economic development driver for industry and communities
- Employment – trades skills are transferrable from oil & gas to geothermal, also requires HVAC, plumbing, electrical, drilling contractors
- Food security – particularly, for northern communities (e.g. greenhouse heating and lengthening growing season)
- Annual fuel savings

ENVIRONMENT

- Natural Resources Canada and Environmental Protection Agency acknowledge GeoExchange (geothermal heat pumps) as the most energy efficient, cost-effective, low environmental impact energy source for space conditioning (heating/cooling)
- Decrease greenhouse gas emissions when compared to conventional heating systems
- Decrease electricity consumption when compared to electrical baseboard heating

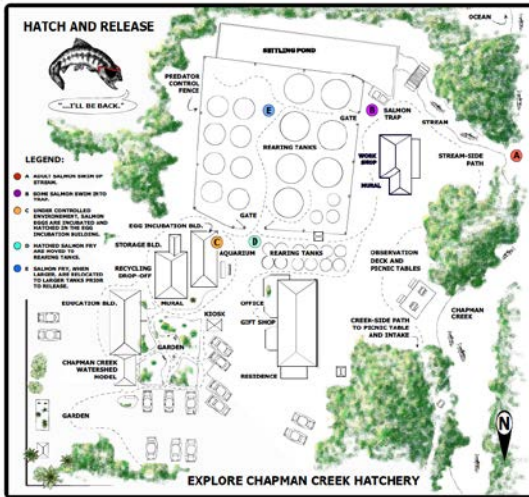
Power → Direct-use → GeoExchange

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>

BC Geothermal Case Studies



Chapman Creek Hatchery, Sechelt BC

- 5 kW micro hydropower and 20 kW geothermal heating system for the facility
- Hybridized geotherma-hydro system resulted in savings up to 75% of power consumption
- facility 100% energy efficient
- <http://www.carnotechenergy.com/projects/the-chapman-creek-hatchery-2/>

Residential Home, Redrock BC (near Prince George)

- Heat Pump Capacity: 26.4 kW, horizontal ground loop system
- Annual Operating Cost \$1,100, compared to electric heating saves \$4,400/yr (no access to natural gas)
- 8 year payback period
- <http://www.earthfire-energy.ca/project/geothermal-installation/>



Residential Home, Redrock BC



Chalet at Blue River, British Columbia

Blue River Resort, BC

- 10 buildings (39,600 sq ft)
- Closed loop, vertical boreholes
- 23 heat pump units, total capacity 103 HVAC tons
- Temperature extremes +40C, -40C
- Installation costs were ~20% more than conventional alternatives, operating costs ~1/4 of conventional heating
- <http://altech1080.tripod.com/blue.htm>

BC Geothermal Case Studies

Sun Rivers Resort Community, Kamloops BC

- Private utility providing geothermal heating and cooling through Corix Multi-Utility Service in Kamloops, BC

UBC Okanagan Campus, Kelowna BC

- Hybrid Direct-use (drilled wells) and open loop GeoExchange
- 3 phases of construction
- 9 years of project development history

Alexandra District Energy System, Richmond BC

- New housing development, services 1,200 units
- 385 boreholes, 76 m deep
- Reduction of 6,000 tonnes GHG emissions annually

Gibsons District Energy System, Gibsons BC

- New housing development, 155 detached homes, municipally owned
- Ground-loop configuration, potential to service ~250-300 additional homes

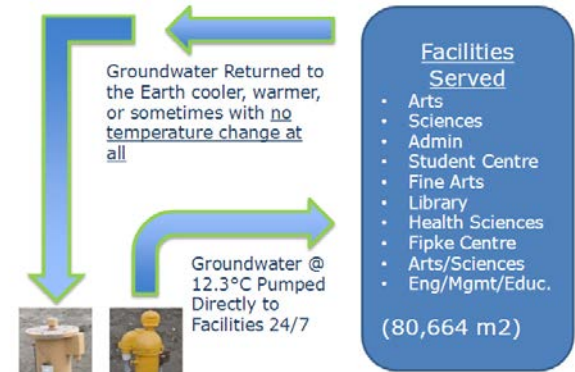


<http://sunrivers.com/utilities-infrastructure/>



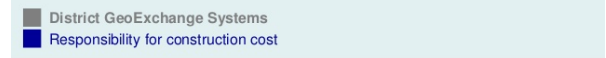
Alexandra DES, Richmond BC

http://www2.canadianconsultingengineer.com/awards/pdfs/2013/E8_AlexandraDistrictEnergyGeothermal.pdf



UBC Okanagan Campus

<http://www.geo-exchange.ca/Download/Conference2013/Day1/Hutchison%20-%202013%20Canadian%20GeoExchange%20Conference.pdf>



- Town installs, owns and operates the GHX and pump house.
- Developer installs the distribution piping & curb stop valves, & turns it over to town
- Home builder / owner is responsible for connections mechanical system

The total cost of the energy source (GHX, pump house, distribution piping and connections to home is approximately \$8,100...20% to 40% less than individual GHX.



Gibsons District Energy System

<http://www.slideshare.net/jeffranson/district-geoexchange-systems>

Northeast BC potential

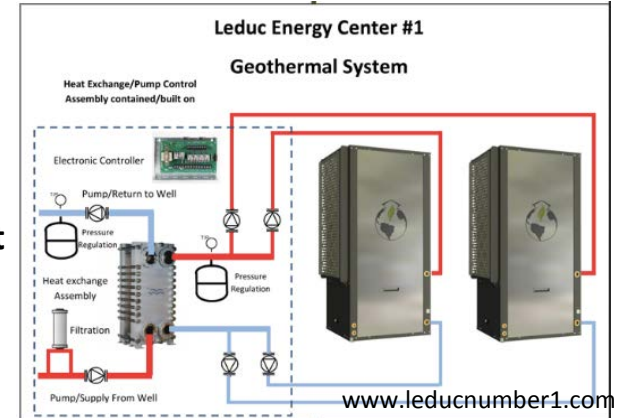


Saskatchewan: Williston Basin

- 5 MW net geothermal binary power plant
- 120°C brine from 3 production wells drilled to 3,200 m
- \$1.04M Funding in 2013 by EcoEI

Alberta: Leduc # 1 Living Energy Project

- In October 2016, abandoned oil well being prepared for conversion to a geothermal heating system
- Geothermal greenhouses, heating for farms

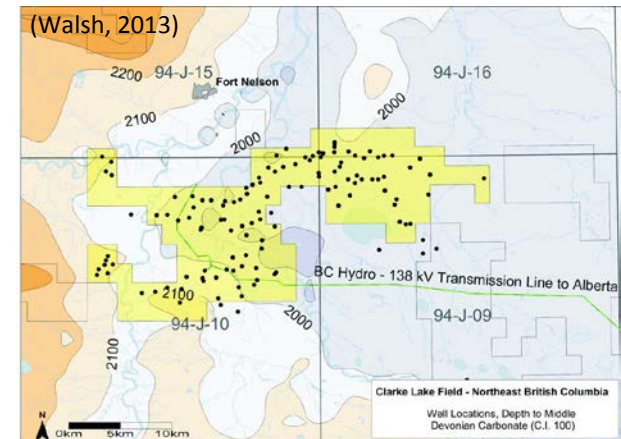
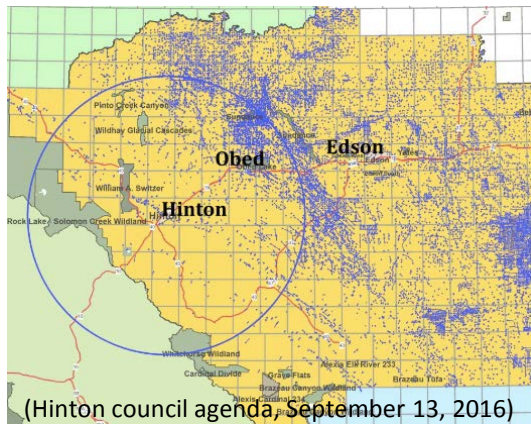


Alberta: the town of Hinton

- Partnership with U of Alberta and Alberta Innovates and other participating municipalities
- \$20,000 - \$25,000 preliminary assessment study to determine volume of geothermal energy available

BC: Clarke Lake oil & gas field

- Middle Devonian carbonate rocks: permeable reservoir with T ~110°C
- 6-7.5 MW potential per geothermal binary plant
- Overall potential 34 MW, "Measured Resource"



CURRENT DEVELOPMENTS – CASE STUDIES

- Valemount BC: Canada’s next “Geothermal Village”
 - Speaker: Korie Marshall, Valemount Geothermal Society

- Xa’Xtsa-Douglas First Nation: Tourism and Geothermal
 - Speaker: d’Artagnan Newton, Consultant to Xa’Xtsa-Douglas First Nation

Barriers of Geothermal

TECHNICAL

- Lack of subsurface knowledge (ie. hydrogeology and thermal properties)
- Every system is unique and requires engineering expertise

PUBLIC AWARENESS

- Widespread implementation in educational programs
- Should be included in all government incentives as a renewable energy technology
- incentives, benefits, tax breaks etc needed
- Lack of resources: **goal of this project is to provide as much information in one location**
- www.bcgeoheat.com

COST

- Competitive hydro, natural gas and biomass pricing
- Higher upfront costs (but lower operational/maintenance costs over life of system)

Access to Funding Opportunities

- Civic and First Nation communities:
 - BC Rural Dividend Fund
 - EcoAction Community Funding Program
 - Northern Development Initiative Trust Funding Programs
 - Sustainable Development Technology Canada
 - New Building Canada Fund – Small Communities Fund
 - Western Diversification Program
 - Western Innovation Initiative
 - Many other potential sources available using this guide: http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/electricity-alternative-energy/community_energy_funding_and_support_guide_-_june_2016.pdf

Resources for Communities

- **Geoscience BC Report (Summary and Roadmap)**
 - <http://www.geosciencebc.com/s/Report2016-07.asp>
- **New Website with additional resources**
 - www.bcgeoheat.com
 - Case studies of geothermal use in British Columbia
 - Funding opportunities
- **Learning Modules**
 - 10 modules
 - available as pdf slide presentations and recorded webinars
 - Also available on www.bcgeoheat.com

Direct-use Follow-up Project (Aug to Dec 2016)

WEBINAR INDEX

MODULE 1	Introduction & Report Overview
MODULE 2	What is, Where is and Why Geothermal?
MODULE 3	Geothermal Power, Direct-use and GeoExchange
MODULE 4	Development Steps
MODULE 5	Environmental Considerations
MODULE 6	Permitting Overview
MODULE 7	Economic Considerations
MODULE 8	Funding Options
MODULE 9	Case Studies
MODULE 10	Summary of Follow-up Project



DIRECT-USE FOLLOW-UP PROJECT - website

Link to Geoscience BC Report:
Direct-Use Geothermal Resources
in British Columbia

BC GEOHEAT



Home

The Project

Resources

Contact

Blog

BC GEOTHERMAL Direct-use

Reliable, Proven Technology

Green, Sustainable, Clean, Low Carbon

Cost-competitive

Local Jobs

Economic Development Opportunities

Entrepreneurship Opportunities

"Cascading uses" - use the same
geothermal heat source for
multiple end uses

[Learn More](#)



LEARNING MODULES

**Direct-Use Geothermal Resources
in British Columbia**

DIRECT-USE FOLLOW-UP PROJECT - website

BC GEOHEAT



**Link to Geoscience BC Report:
Direct-Use Geothermal Resources
in British Columbia**

[Home](#) [The Project](#) [Resources](#) [Contact](#) [Blog](#)

Webinar Index

GEOSCIENCE BC REPORT SUMMARY

OBJECTIVE

- Identify and evaluate Direct-use geothermal energy opportunities for BC communities
 - Potential to reduce greenhouse gas emissions and drive economic development
 - Review of various Direct-use development possibilities as applicable to BC
 - Gather detailed community information on the 11 sites deemed 'favorable' for electric generation in KWL & Geoscience BC report
 - 63 communities were contacted for information about their nearby resource
 - Through this process, the Project sought to give BC communities and businesses an understanding of availability of resources and steps required for resource evaluation
 - This study did not evaluate the use of heat pumps for ground-based geothermal (geoexchange) due to the ubiquitous nature of the low temperature resource involved
 - However, it is recognized that their deployment is an important aspect of Direct-use resource development, particularly for raising awareness of direct-use applications

Geoscience BC, Tuya Terra Geo Corp., BRITISH COLUMBIA

Module 1 (PDF)

Introduction and Report 2016-07 Overview

What is Geothermal?
An Idealized Geothermal System

Essential components for a good resource are:

- 1) heat
- 2) permeability
- 3) fluid

Geoscience BC, Tuya Terra Geo Corp.

Module 2 (PDF)

What is, Where is, and Why Geothermal?

Suggested Steps for Communities

1. Refer to Geoscience BC Report (Summary and Roadmap)
 - <http://www.geosciencebc.com/s/Report2016-07.asp>
2. Look through/watch/listen to modules/webinar presentations made available on website
 - www.bcgeoheat.com
3. Evaluate the staff capacity to undertake grant proposals for the various funding/grant opportunities
 - Covered on Module 8 of Webinars
 - http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/electricity-alternative-energy/community_energy_funding_and_support_guide_-_june_2016.pdf
4. If there is no Community Energy Plan (CEP) in place, a community should access support provided by BC government and other organizations (Community Energy Association, BC Hydro) to have one completed
 - A CEP is a tool that helps define community priorities around energy with a view to improving efficiency, cutting emissions and driving economic development
5. If there are any questions about how to move forward, contact Geoscience BC/Tuya Terra Geo Corp.

References

Alexandra District Energy System, Richmond BC, accessed Dec 2016.

http://www2.canadianconsultingengineer.com/awards/pdfs/2013/E8_AlexandraDistrictenergyGeothermal.pdf

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Direct-use Geothermal Resources in BC, 2016. Geoscience BC, Report 2016-07. <http://www.geosciencebc.com/s/Report2016-07.asp>
additional information accessible on www.bcgeoheat.com

Geothermal Education Office, 2016. Geothermal energy uses at different temperatures. <http://geothermaleducation.org/>

Government of BC, 2016. Support Program Guide for First Nation & Civic
Community Energy Efficiency & Clean Energy Projects.

http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/electricity-alternative-energy/community_energy_funding_and_support_guide_-_june_2016.pdf

Lund and Boyd, 2015. Direct Utilization of Geothermal Energy 2015 Worldwide Review. Proceedings World Geothermal Congress 2015, Melbourne, Australia, 19-25 April 2015. <https://pangea.stanford.edu/ERE/db/WGC/papers/WGC/2015/01000.pdf>



Xa'xtsa – Douglas First Nation

Potential site for small scale
geothermal energy production at
Sloquet Creek

January 2017

Presenter: d'Artagnan Newton

Xa'xtsa-background

- Xa'xtsa is a small First Nation band which is part of the larger Stl'atl'imx nation
- Xa'xtsa has archaeological evidence of over 5000 years of living in the area
- 60 people living on 2 small reserves: Port Douglas and Tipella
- Connected to the grid in 2010 following the successful completion of a number of run of the river power projects
- Substantial artesian hot water supply near the reserve of Tipella

Location of community and hot springs



Distance from hot water to Logging camp 5.2 km as crow flies and
About 6km to Tipella

Sloquet Hot Springs



Site investigation reports

- Sloquet has numerous surface hot water outflows along Sloquet Creek with temperatures up to 68 degrees centigrade
- BC Hydro reports from 1975 – onwards, suggest hot water is available over a 2km zone
- Potential for hot water to exist at depth at the logging camp
- Forest Service Road provides easy access to zone for drilling rig access

Xa'xtsa's has these projects in the planning stage

- Sightseeing bus tour to Sloquet Hot Springs due to launch early 2017
- Development of a new hot pool complex close to the existing Sloquet site.
- Starting a sawmill operation by mid-2017
- Art and Craft manufacturing and retail in Tipella – due for starting Spring 2017
- Archaeological tours and education programs – in planning stage
- Expanding facilities at loggers camp for tourist camping – in planning stage
- Agriculture Project – starting Spring 2017

Geothermal energy uses/potential

- Direct use heating to office, cabins, store and washrooms at new hot pool project near Sloquet
- Provide direct heating for planned greenhouse as part of new agriculture project
- Provide direct heating to logging camp
- Would be a unique feature for a First Nation owned tourism business

Community support for clean energy

- Identified through Comprehensive Community Plan: May 2015
- Plan to use clean energy to support the bands 'diverse revenue streams'
- Solar and wind generation also considered
- Help to develop skills and training for sustainable employment within the community

Culture is thriving: Economic Development will help support communities to survive



Valemount BC: Canada's next "Geothermal Village"

Korie Marshall, President
Valemount Geothermal Society

Where is Valemount?



Why Valemount? A brief history...

- Borealis Geopower gets first geothermal permit in BC in 2010 (Canoe Reach)
- VoV hires MMM for pre-feasibility study of District Energy System using geothermal (2012)
- KRIFO Report cites geothermal exploration as one of 3 business cases proposed to mitigate local effects of the CRT (2013)



Geothermal Workshop Feb 2016

- Valemount Community Forest developing new Industrial Park
- Speakers from BC , Oregon and Alaska, CanGEA and Borealis Geopower
- Geothermal Potential that excited locals:
 - Hot Springs
 - Direct Heat Use Geopark
 - Electricity Generation (Borealis GeoPower)



The beginnings of a committee

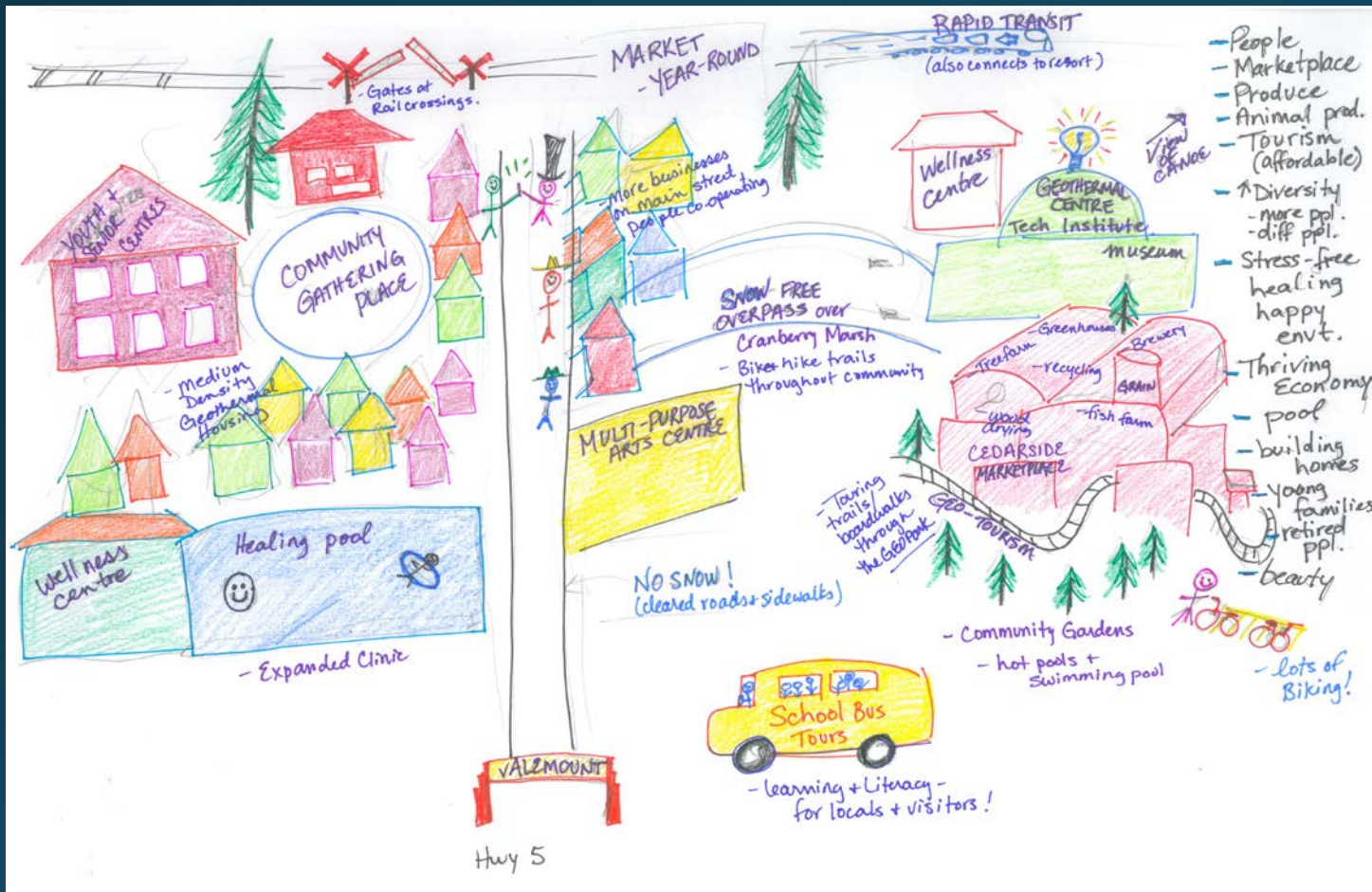
- Residents were excited about potential of geothermal:
 - A clean, stable and renewable energy source, low environmental impact
 - Help improve the local economy – business opportunities and jobs
 - Help improve local food security by expanding our growing season
- Community members:
 - Made presentations to Council, local Chamber of Commerce
 - Met informally to discuss how we could support and help move geothermal forward
- Geoscience BC's report on Direct-Use Geothermal Resources in BC cited Valemount as a model for other communities

Valemount Geothermal Society



- Officially incorporated non-profit in May 2016
- Purpose: to develop geothermal resources for the enhancement of Valemount and surrounding areas
- Currently have 40 paid members
- Held visioning and planning sessions, and local stakeholder engagement sessions

Vision & Strategic Planning Session

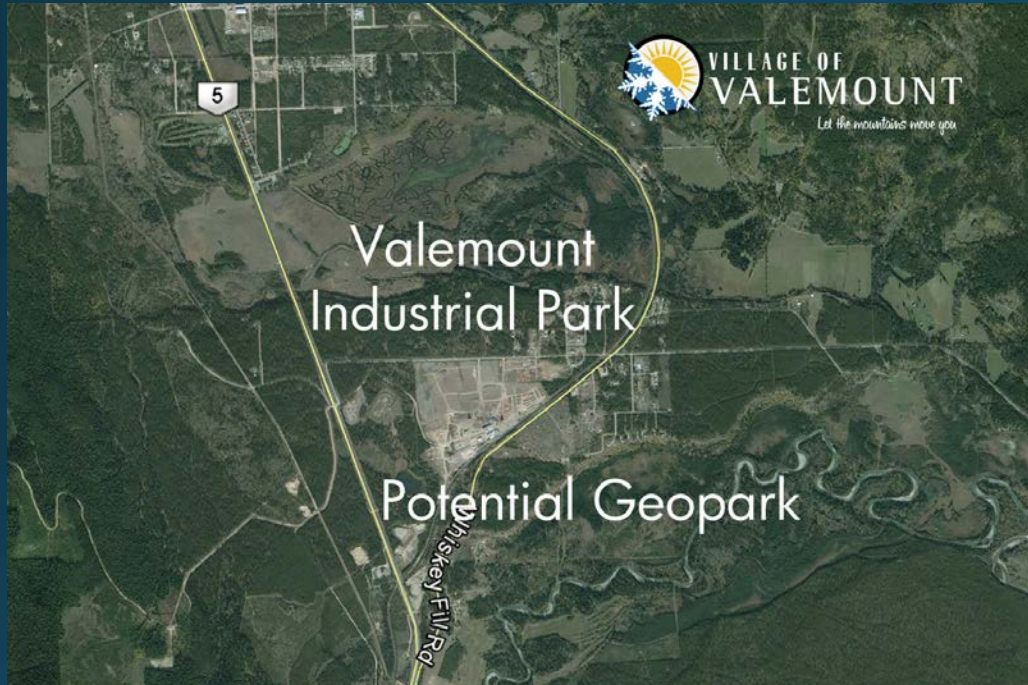


"Our vision is of a thriving, sustainable local economy that is enhanced by the use of geothermal energy. We hope to build this economy through innovation, learning and cooperation with integrity and diversity as core values."

Economic/community development potential of geothermal for Valemount

- Working with VCF to attract, expand and create local small businesses → more jobs, more residents, improved food security
- Businesses working together to use each other's waste products (eg. Brewery and greenhouses)
- More reliable and stable electricity and heat with less environmental impact
- Show and tell others they can do it too – geotourism – trails, interpretive centres, tech institute, marketplace for local businesses

Direct Heat Use Committee



- Select Committee appointed by Village of Valemount Council
- Focus on Direct Heat Use at the VCF Industrial park
- VGS communicates with and supports efforts of the DHU committee and their recommendations to Council

VGS – Hot Springs



Inspired by temporary access to heat from original Canoe Reach hot spring in early 2016



Decision in January 2017 to pursue development of a new hot pool in conjunction with Borealis Geopower's Phase 1



Next Steps...

- Continue engaging Simpcw First Nation
- Business Plan
- Grants/fundraising
- Partnerships
- MOU with BG
- Support VCF and Council/DHU in pursuing "GeoPark"
- Other steps?

