Datathon For The Oil and Gas Industry
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REPORT

Repurposing Aging Infrastructure

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Overview

The objective of this pod is to visualize the opportunities that exist for using existing oil and gas well bores for geothermal power or heat generation. We analyzed production data to calculate flow rates, geo-cluster of green-house gas emitters and oil and gas companies with poor licensee liability ratings.

Action items and path forward include understanding the economics of converting specific types of wells into geothermal energy generation wells. Also getting a distribution of investment budgets for municipalities to ensure that the costs of converting a well falls in line with the spending expectations of tax payers and private companies.

Objective

The objective of this pod is to visualize the opportunities that exist for using existing oil and gas well bores for geothermal power or heat generation in Alberta. Specifically how would oil and gas operators and other industries benefit from the existing infrastructure.

Technical Summary

The list of data sources include public and private.

- ## External Data

1. Interactive dashboard by NEXOV Canada :
    a. https://www.nexovcanada.com/
2. National Pollutant Release Inventory dataset for Alberta:
    a. https://www.canada.ca/en/services/environment/pollution-waste-management/national-pollutant-release-inventory.html
3. Liability Management ratings from the Alberta Energy Regulator
    a. https://www.aer.ca/regulating-development/project-closure/liability-management-programs-and-processes/liability-management-rating-and-reporting
4. University of Alberta report on geothermal energy potential in Alberta:
    a. http://www.ai-ees.ca/wp-content/uploads/2017/04/Deep-Dive-Analysis-of-Best-Geothermal-Reservoirs-for-Commercial-Dev....pdf
5. Interactive pool maps from the Alberta Energy Regulator:
    a. http://mapviewer.aer.ca/Html5/Index.html?viewer=aerorder
6. Data from JWN (The CanOils database) : List of all Alberta Active or Suspended wells:

a. General well characteristics (ie. Operator/Licensee, Field/Pool/Formation, Lat/Long, Objective, Total/Vertical Depth, Twn-Rng, etc...)
b. Temporal information (ie. License, Spud, Rig Release, Abandonment, last production dates).
c. Aggregated Gross Monthly Production (BOE, Oil, Condensate, Gas, Water)
d. Broken-down as last-reported, initial, current, 3/6/9/12mo trailing (ideally trailing from last production date, but need to discuss with the data guys)
e. Oilfield Atlas database, which will include generalized information on Facilities as follows:
f. Current operator
g. Lat/Long coordinates

• Tools and Technologies

- Power BI
- Rstudio/R
- Jupyter/Python
- Excel

• Analysis Techniques

An important source of information came from a study from the University of Alberta undertaken by Jonathan Banks which focuses on the geothermal potential in four counties: Grand Prairie, Greenview, Yellowhead, Clearwater. This study also carefully outlined the cost associated with converting a conventional gas well to a slim-hole geothermal power or heat source. Furthermore, the costs of installing surface equipment for an organic ranking cycle.

A second aspect of our analysis focuses on all of Alberta to understand flow rates from wells that could potentially also be converted. This second part of the analysis was done by pod members Shlok, Tony, and Shay from Nexov Canada.

To calculate flow rates:

- Our team calculated the flow rates from the data provided by JWN. There were two methods used, based on the area of interest. Tony looked at province-wide flow rates as a high level overview; while Somayeh looked at flow rates strictly in the four counties outlined in the U of A study.
- Subject Matter Expert Tony: Suspended or flowing (only prior to 2015 to avoid skewing the data towards high-flow new drills), drilled after 1990 (limit of data

from JWN), oil or water wells. We calculated rates based on the cumulative fluid produced and the dates from spud date to last produced.

- Subject Matter Expert Somayeh: Based on start of production from the JWN data to final date of production, the average fluid rate was calculated. The types of wells used were both suspended and abandoned.

Temperatures:

- Subject Matter Expert Brett : Bottom-hole temperature data was calculated based on an academic paper published in Energies by Simon Weides and Jacek Majorowicz called “Implications of Spatial Variability in Heat Flow for Geothermal Resource Evaluation in Large Foreland Basins: The Case of the Western Canada Sedimentary Basin”.

Green-house gas emissions:

- Subject Matter Expert Albert and Shlok: An important source of data is the distribution of emitters of green-house gases and understanding the types of industries that could potentially benefit. A way to visualize this was to create heat maps of green-house gas emitters by tons of CO2 equivalent. Then to be able to filter based on industry or facility type.

Liability Ratings:

- Subject Matter Expert Britta and Terry: The Licensee Liability Rating determines the amount of liabilities an oil and gas operator has with respect to its assets. This dataset may be important when determining which oil and gas companies could benefit from geothermal energy production. As companies with relatively low liability management ratings (LMR, i.e. low ratio of assets to liability) could benefit from converting wells to geothermal power or heat generation.

Visualization:

- Subject matter expert Steven developed a markdown HTML document in R Studio that shows different types maps of the list of wells that were obtained from the analysis within the area of interest. The maps developed are :
    - Flow rate
    - Estimated cost
    - Bottom-hole temperature
    - Facilities with Emissions

Key Learnings and Takeaways

Ranking: based on the study done by Jonathan Banks at the University of Alberta, subject matter expert Britta developed a linear regression model that calculated the estimated megawatt of electricity and thermal power from each of the wells. The input data came from the estimated numbers in the U of A report (Table 12). Britta then created a linear regression model from these. The output would then be used to rank the wells to look for candidates. Somayeh also normalized all the variables of interest in the final list (rates, temperature, liability ratings).

- **Key Learnings:** ranking based on flow rates, liability, and bottom-hole temperature can prove to be a good indicator of potential candidates for geothermal power or heat conversion

Visualization: The subject matter experts Steven, Shlok and Tony developed two visualization tools that were used to see the distribution potential wells in the areas of interest (Steven) and all of Alberta (Shlok and Tony).

- **Key Learnings :** An important aspect of understanding the potential for geothermal power generation is to visualize the variables of interest on a map format that be interactively viewed to understand the proximity to different types of infrastructure.

Modelling: Subject matter expert Brett undertook a modelling exercise with the list of wells that were obtained after narrowing down on the areas of interest and adding the flow rates, temperature, conversion costs and liability ratings. The goal of the exercise was to generate a prediction model that could identify the best predicting variables that would predict the associated properties that are ideal for geothermal power generation, and show the potential for machine learning techniques to be applied to future geothermal well conversion prospects.

- **Key Learnings:** With a more robust data set, we may be able to use ML to identify conversion prospects with a high probability of success.

Path forward

An important aspect of the analysis that was not covered in enough depth is the associated economic metrics that would allow for a well conversion to be successful. Although we did include an estimate of costs required for the conversion of each individual well, an important issue that was not discussed is forecasting the estimated power or heat generation and how it could make financial justification to install and maintain a geothermal power or heat generating plant at surface.

Another important piece of information that is missing is understanding the type of costumer that would benefit from the thermal and electric power produced from the conversion of geothermal wells. While we did identify oil and gas operators and different types of industries and facilities that have high green-house gas emissions, it is important to follow up on understanding the geographic proximity of each with respect to the wells with highest geothermal potential.