Evaluating Geothermal Energy Production from Suspended Oil and Gas Wells by Using Artificial Intelligence

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Although geothermal is among the renewable energy sources, the relatively high cost of well drilling and completion limits the development of geothermal resources. On the other hand, tight oil and gas resources have been successfully developed over the last decade due to advances in horizontal drilling and multi-stage hydraulic fracturing technologies. However, hydrocarbon production rate declines rapidly below the economic rate after few years and the operators abandon the multi-fractured horizontal wells (MFHWs). Canada has more than 65,000 suspended oil and gas wells completed in the Western Canadian Sedimentary Basin (WCSB) with reported bottomhole temperature at the public database, with more than a thousand of suspended MFHWs. Can these wells be retrofitted to generate geothermal power? The objective of this study is to answer this question by investigating the geothermal potential of suspended wells completed in WCSB and identify the best candidate wells for repurposing.

In this study, we collect temperature logs and well-completion data of suspended oil and gas wells completed in WCSB. We utilized the validated the temperature log data to develop a contour map of temperature gradient (TG) distribution in WCSB. Then, we geostatistically interpolated TG at each suspended well to verify the reported bottomhole temperature (BHT). The distance from each suspended well to the nearby power plant, power line and residential area is estimated and used along with the verified BHT, TG, true vertical depth (TVD), wellbore diameter and well's completion year to estimate the geothermal potential of each suspended well using a developed supervised fuzzy clustering (SFC) algorithm.

The results show that more than 800 suspended wells are classified with Good geothermal potential that could deliver up to 29.83 MW of geothermal power to directly heat more than 2,700 private dwellings in the nearest 163 residential areas as shown in **Figure 1**. There are 13 suspended wells where each one could deliver more than 100KW of geothermal power to the nearest residential areas considering the heat loss in surface pipelines. There are 42 suspended MFHWs with good geothermal potential and among these wells there are four pairs ranked as most successful candidates for retrofitting to enhanced geothermal system (EGS) as shown in **Figure 2** and **3**, respectively. There are hundreds of suspended wells that are located in regions with high temperature gradient ($\geq 4.5^{o}$C/100m) but with limited potential of geothermal energy extraction either because they are not deep enough (< 1,500m) to reach hot formations, or far from nearby power grids and residential areas (> 30km) as shown in **Figure 4**.

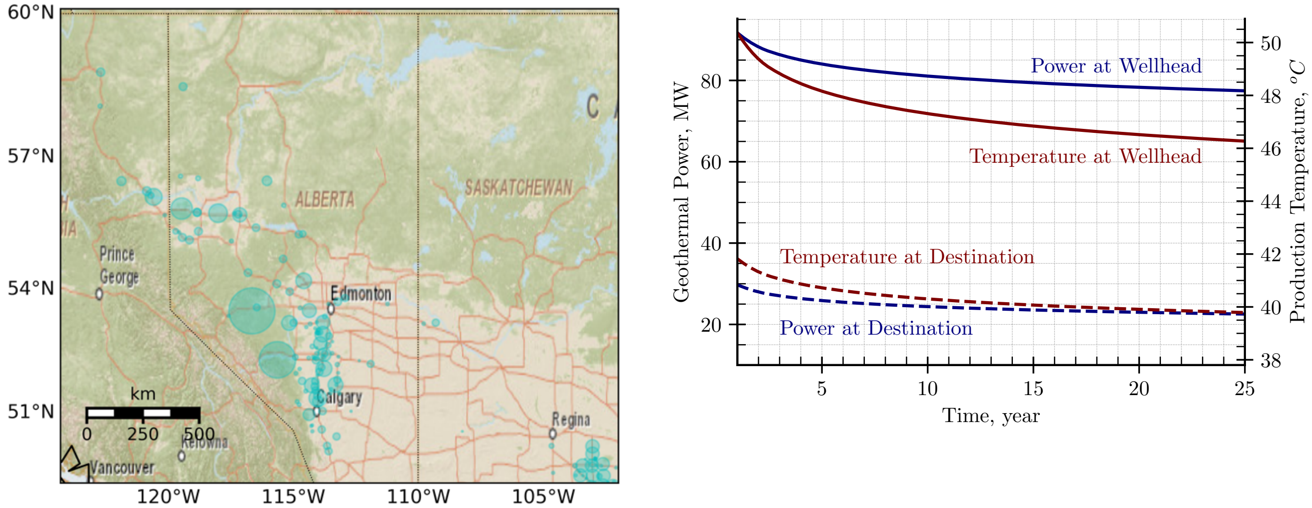

Figure 1 – Potential residential areas to be served by the geothermal power extracted from nearby suspended wells with "Good" geothermal potential

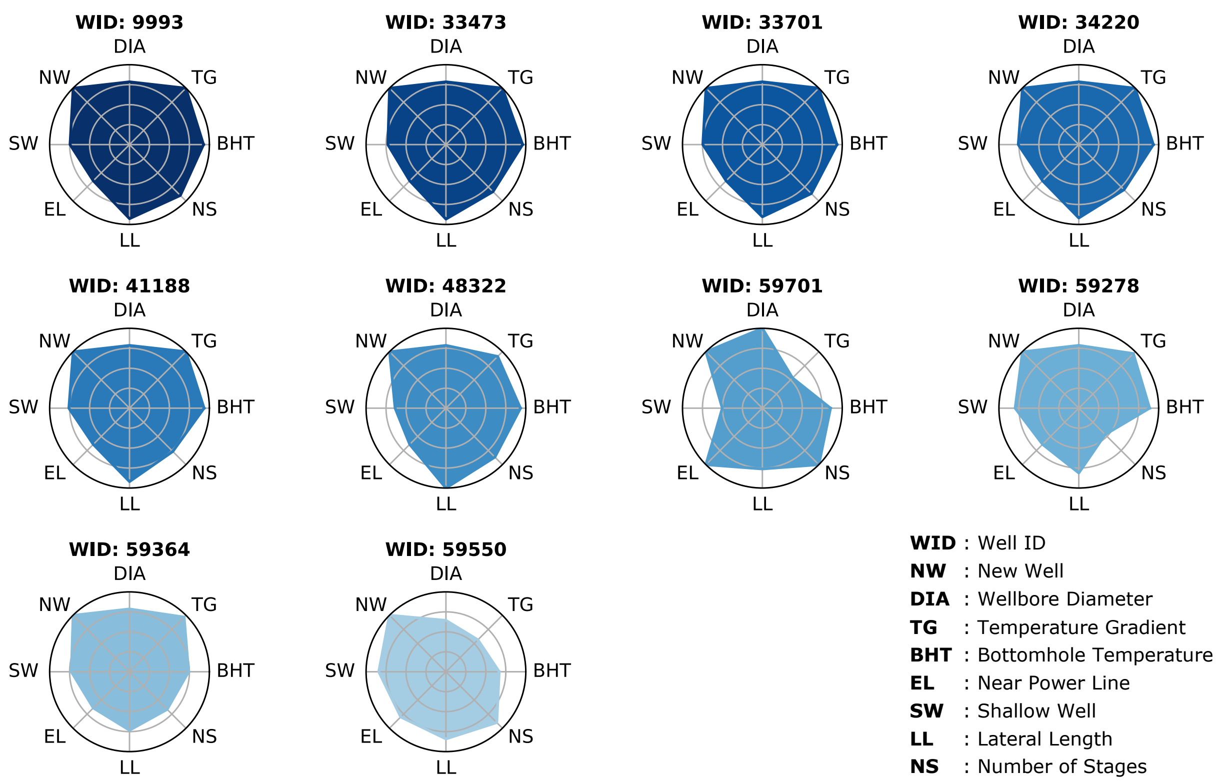

Figure 2 - Normalized completion properties of the 10 suspended MFHWs wells with the highest geothermal potential

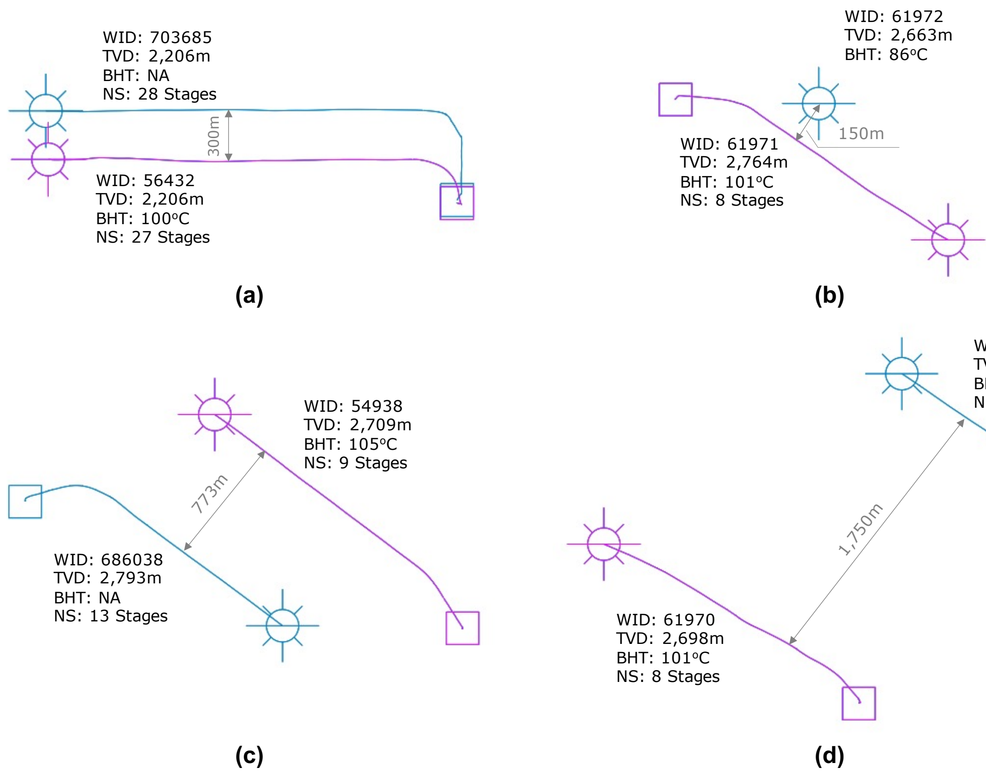

Figure 3 – Examples of suspended MFHWs with the distance to the neighbor suspended well, showing the potential of retrofitting these well pairs into enhanced geothermal systems

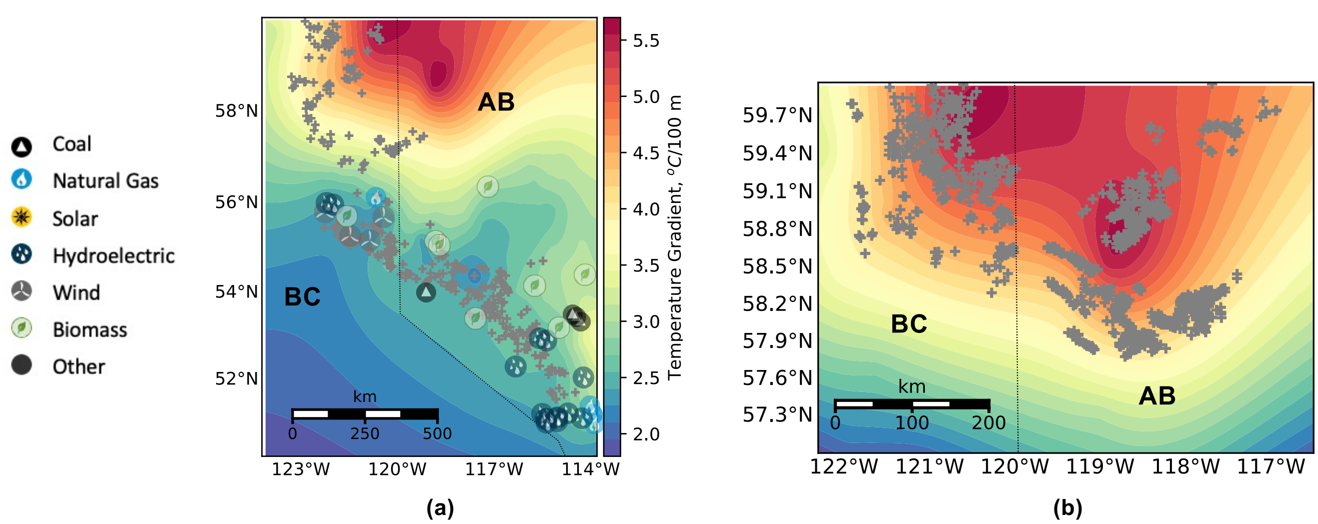

Figure 4 – **(a)** The suspended wells with BHT above 100ºC and nearby power plants. **(b)** Suspended wells with depth less than 1,500m in regions with temperature gradient above 4.5ºC/100m