Upcycling Orphan Wells in Alberta: Repurposing Opportunities using a New Evaluation System

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Orphan wells refer to oil and gas wells taken out of production, often based on financial, environmental, regulatory, or other considerations. Today, there are over 90,000 inactive wells in Alberta, which are vulnerable to becoming orphan wells. The number of orphan wells increased by approximately 4500% between 2012 and 2019, while the number of wells reclaimed decreased by approximately 50% between 2016 and 2019[1]. In addition, abandoned orphan wells that leak may cause severe environmental issues resulting from fugitive gas emissions (often methane) to the atmosphere and the groundwater. Repurposing of existing wells and modification of construction specifications for new wells offers a range of solutions to some genuine challenges being faced by the energy sector in Alberta today. This study demonstrates how long-term, multi-purpose well design considerations can, with minimal adjustments, accommodate conversion to various alternative uses.

An evaluation system was developed that could triage a well (orphan or otherwise) for potential reuse applications. The new evaluation system was created through the development of an accurate range of variability around existing well specifications. Key parameters of different aspects of wells such as production history, wellbore integrity, reservoir properties, thermal gradients and relative energy distributions were analyzed. Different repurposing options were selected which include Compressed Air Energy Storage (CAES), geothermal development, waste disposal, mineral mining, CO2 Storage (CCS), and Enhanced Oil Recovery (EOR). Case studies were developed to test the evaluation system, based on data from two sites in Alberta. This was completed using data collected from the OWA and the AER using GeoScout™. There are wells that have the potential to easily (and inexpensively) be turned into CAES systems for Solar power storage or for geothermal (heating/greenhouses and energy) development, as demonstrated by the two case studies. Orphan wells, converted for CAES, can increase the production and performance of solar energy. Converting orphan wells into geothermal wells is a viable option since the average thermal gradient in many sites of Alberta is greater than the global average (25~30^{o}C /km)[2].

"Canada's economic future us dependent upon natural resource and energy development and has therefore become inextricably linked to the rights and interest of Canada's Aboriginal Peoples." Our project includes reaching out to Indigenous communities and Indigenous owned and operated energy development companies to learn about barriers experienced in this industry and what is possible if we could find solutions to the restrictions of re-using orphan wells. The application of the evaluation system introduced in this study advances our knowledge of the economic and environmental benefits of repurposing orphan wells. This information is pivotal in defining necessary updates to existing policies and regulations.

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Footnotes:

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References:

[1] *Alberta, O., Gas, O. A., & Reclamation Association. 2018. Orphan Well Association 2018-19 annual report.*
[2] *Northern Alberta Geothermal Potential Mapping Project – Final Report. (February 2019).*
[3] Laurin, W. M.; Jamieson, J. P. (2015). Aligning energy development with the interests of aboriginal peoples in Canada. Alberta Law Review, 53(2), 453-480.
[4] *CleanTech Geomechanics Inc. (CTG). https://cleantechgeo.com/cwcas-speci_cations*
[5] *Lake, L. W. (1989). Enhanced oil recovery.*
[6] *Alberta Favorability Maps. (March 2013). Geothermal Favourability Map of Alberta following a Global Protocol Methods and Data Sources. Final Report.*
[7] *ALCES Inc, https://www.alces.ca/data/*

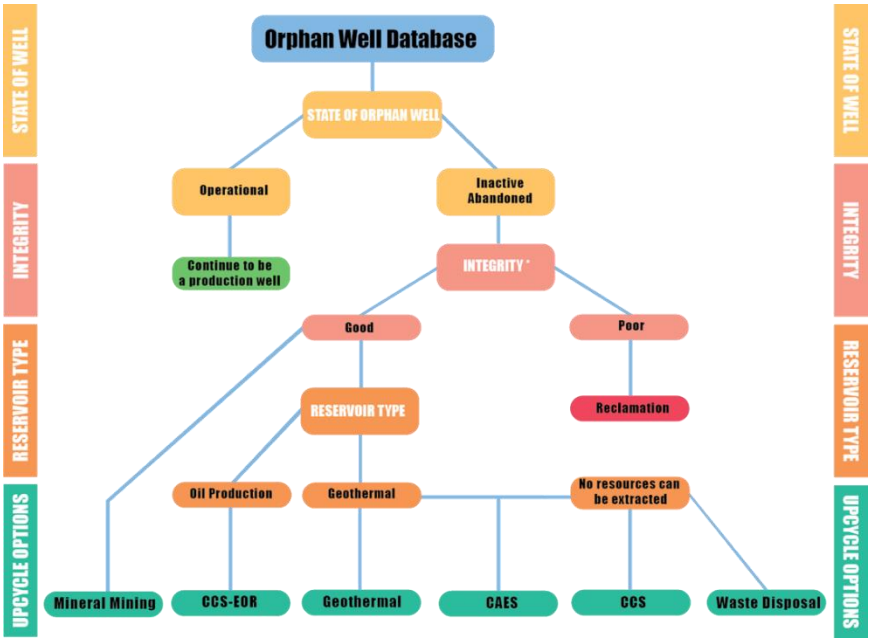

Figure 1: Flowchart for evaluating reuse options for orphan wells.

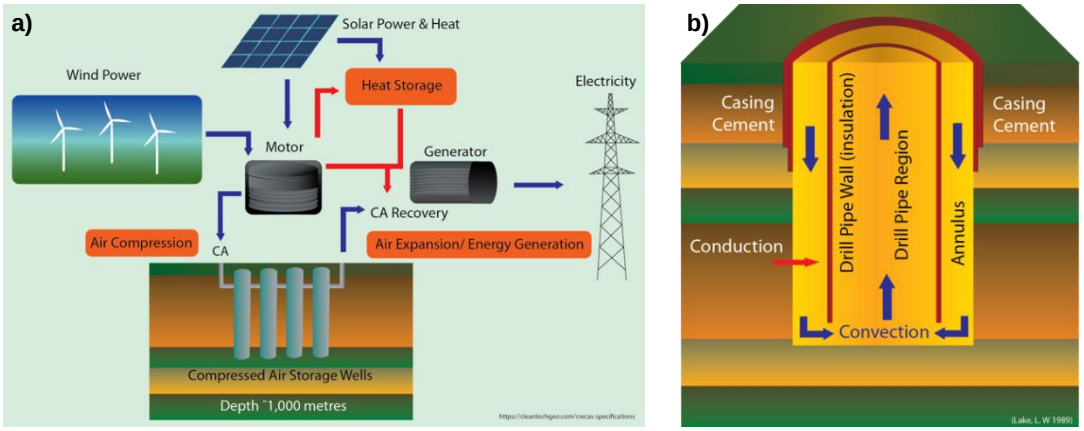

Figure 2: Technical specifications for **(a)** compressed air energy storage (or CAES) (wind or solar)[4] and **(b)** geothermal energy[5]. The evaluation system could determine which orphan wells would be suitable for alternative energy applications.

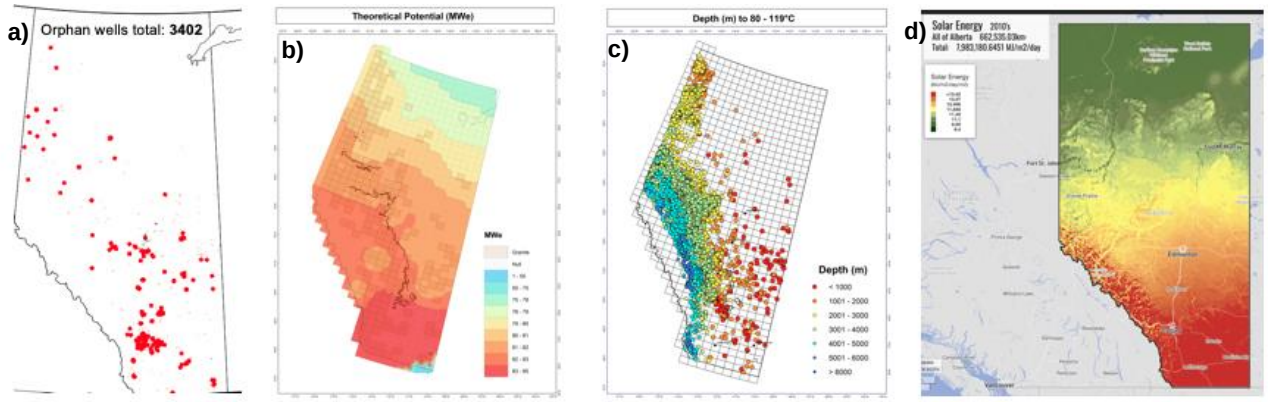

Figure 3. Justification of case study sites in Alberta using: **(a)** Orphan well distribution, **(b-c)** Geothermal potential[6] and **(d)** Solar potential[7].

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