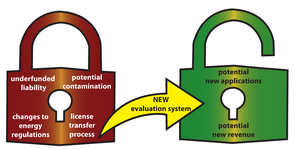
NSERC CRSNG
Scholarship Recipients of **CREATE** Grant #386133824
(Collaborative Research and Training Experience)

Upcycling Orphan Wells in Alberta

Repurposing Opportunities with a New Evaluation System

Shelley Alexander [1], Jiujie Cai [2], Laura Flinkfelt [3], Li Li [4]

Repurposing Wells



- Potential re-use of orphan and other inactive wells may be **unlocked through an effective evaluation system** that pairs technical parameters and well characteristics.

1. Introduction

- **Orphan wells, in Alberta, are wells that no longer have a financially responsible owner.** The liability is taken over by the Alberta Energy Regulator (the Alberta taxpayer) and becomes part of the Orphan Well Association inventory. The fate of these orphaned wells is to remain in an abandoned state until funding and priority eventually remediate and reclaim the wellsite to as-close-to the land's original state as possible. The landowner is unable to use the wellsite until after this process is completed. While the well is part of the OWA inventory, a landowner is often not receiving any payments for the well site lands and is unable to use the land as a revenue stream.
- **Team Orphan Well, through the Redevelop program, has been working on building an evaluation system that could triage a well** (orphan or otherwise) for potential re-use. The system is tested on two theoretical wells to show the upcycling potential. Both case studies show that there are wells that could be easily (and inexpensively) turned into Compressed Air Energy Storage systems for Solar power storage and as conduits for geothermal (heating/greenhouses and energy).
- **There is industry interest and potential for these upcycling options to become a reality** with enhanced access to well development data. Team Orphan Well has been working toward building relationships with Indigenous representatives in Alberta, discussing orphan well issues and development opportunities for their communities.

2. Regulation & Evaluation

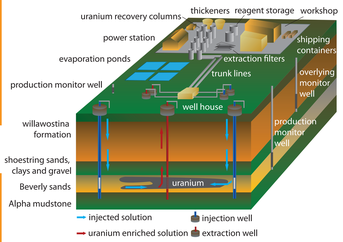
- **Existing levy system** managed by the Alberta Energy Regulator (AER) provides funding to the Orphan Well Association (OWA) to plug, remediate and reclaim orphan well sites.[1,4] Oil companies are obligated to fulfill their remediation and reclamation duties.[1,4] However, the levy system has not been able to support the increasing cost of orphan well liabilities.
- **Potential new legislation** may come into place that will clarify and expand the authority of the OWA to manage the issue. Changes in the financing and regulatory framework for orphan wells may provide the opportunity to integrate upcycling options and increased revenue to address wells that require remediation.[4]
- **Benefits of using the evaluation system**, wells can be categorized and prioritized for reclamation or repurposing. Addressing liability issues and funding for companies that could repurpose suitable wells would be a step towards shifting orphan wells in Alberta from a liability to an opportunity. The repurposing of wells would be based on the evaluation criteria and technical specifications necessary for different options.

3. Partnering with Indigenous Communities

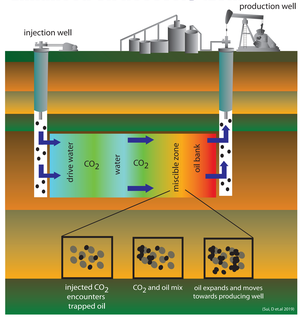
"Canada's economic future is dependent upon natural resource and energy development, and has therefore become inextricably linked to the rights and interests of Canada's Aboriginal peoples."[4]

- **Communications with First Nations**, Team Orphan well has been communicating with Fort McKay, Samson Cree and Alexis First Nations to listen and learn from community members and learn first-hand about their experiences with energy development, orphan wells and interest in alternate uses for orphan wells. This project included reaching out to Indigenous energy development companies to learn about the barriers they experience in the industry and what is possible if we could find solutions to the restrictions of re-using orphan wells.
- **Impact for Communities**, through an attempt to embody "deep" consultation or "Kawithap'matoa"[7] this project has taught Team Orphan Wells that some communities have wells on their lands that were drilled in 1905, that some communities have quite a few orphan wells on their lands that are impacting their ability to use the land for revenue (ranching), and that due to the added complexity of existing in the space between provincial and federal jurisdictions, addressing the liability gaps toward innovative re-use of well infrastructure is still a work in progress.
- **Moving forward**, discussions will continue with Indigenous communities beyond the timeline for this research project to continue to build relationships and mutual learning.

Mineral Mining

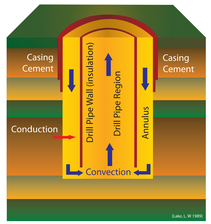


Enhanced Oil Recovery (EOR)



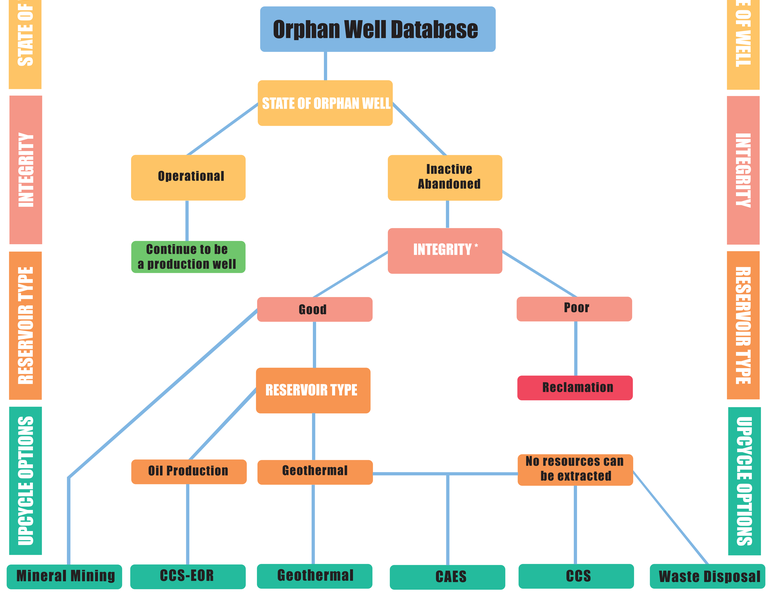
(Xu, D et al 2019)

Geothermal Energy



(Lake, L. W 1989)

4. New Evaluation System

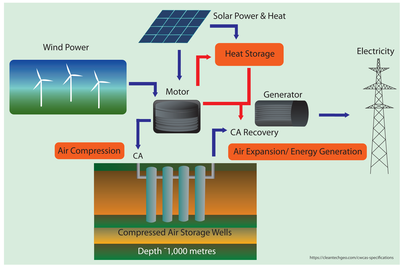


* the integrity of a well is subjective and ranges between wells that require immediate reclamation to wells that are inactive but have the potential to continue to produce oil. It is important to note that as time passes, the integrity of a well degrades. Therefore, action should be taken urgently to address outcomes (including upcycling and reclamation).

7. Recommended Next Steps

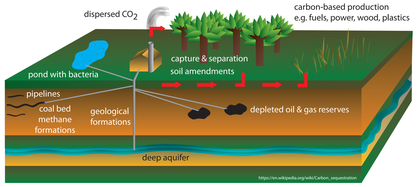
- **Quantitative analysis of each well option** is the primary technical step required to move forward; the case studies of CAES-solar and geothermal energy demonstrate the immense potential of upcycling orphan wells for alternative purposes.
- **Shared data platform** for improved access to data is needed for developing accurate parameters to test the applicability of upcycling options for wells in Alberta.
- **Developing collaborative relationships and engaging with Indigenous communities** to determine suitable well options in these communities, and engaging in meaningful consultation with Indigenous companies that are active in business development to build partnerships is required for any energy development.
- **Further work is needed to develop a regulatory framework** that allows integrated solutions using alternative options for orphan wells while enforcing existing regulations for industry on maintaining the integrity of inactive wells and full financing of orphaned wells.
- **Prioritizing wells that are most suited for upcycling**, and integrating a framework to address legacy and the most problematic wells.
- **Acting quickly, make the time count** to gain the benefits of using upcycling opportunities while wells retain integrity, as more time passes the integrity of any inactive well loses its' integrity, resulting in an increased number of potential wells that may become orphaned and problematic due to poor integrity.

Compressed Air Energy Storage (CAES)



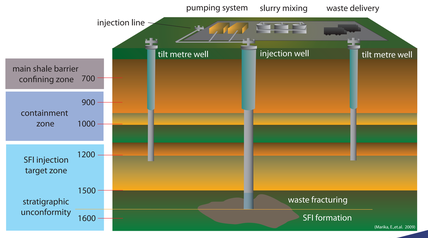
https://exantechgas.com/caes-specifications

Carbon Capture & Storage (CCS)



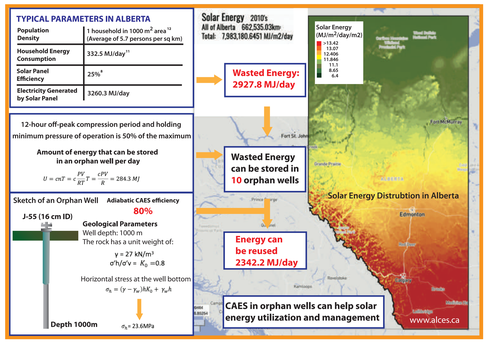
https://en.wikipedia.org/wiki/Carbon_sequestration

Waste Disposal

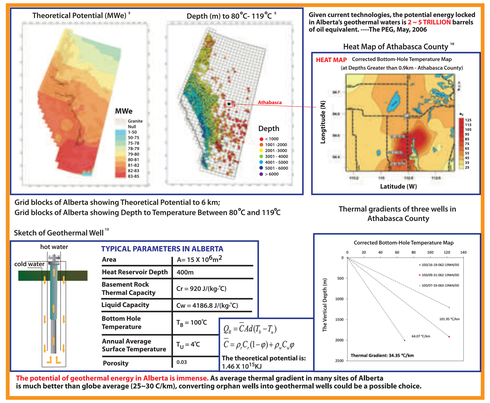


(Marks, E.et.al. 2020)

5. Case Study- CAES for Solar energy



6. Case Study- Geothermal Energy



The potential of geothermal energy in Alberta is immense. As average thermal gradient in many sites of Alberta is much better than globe average (25~30 C/km), converting orphan wells into geothermal wells could be a possible choice.

References & Acknowledgements

1 AER. (2016). Directive 006. Accessed February 1, 2020. https://www.aer.ca/rules-and-regulations/directives/directive-006.
2 ———. (2019). Directives and Manuals. Accessed February 17, 2020. https://www.aer.ca/rules-and-regulations/directives/directives-and-directives/acts-regulations-and-rules.
3 ———. (n.d.). Liability Management Rating and Reporting. Accessed February 17, 2020. https://www.aer.ca/regulating-development/project-closure/liability-management-programs-and-processes/liability-management-rating-and-reporting.
4 ———. (n.d.). Orphan Well Association. Accessed November 20, 2019. https://www.aer.ca/regulating-development/project-closure/liability-management-programs-and-processes/orphan-well-association.
5 Alberta Energy Regulator. (2019). Directive 056: Energy Development Applications and Schedules. Calgary, Alberta: Alberta Energy Regulator. Methods and Data Sources. Final Report.
6 Laurin, M-M. (ernlaurin_). (7 (2015). Aligning energy development with the interests of aboriginal peoples in canada. Alberta Law Review, 53(2), 453-480.
7 Lertzman, D. (2016). January 11). Illegal SAT. 2018 [Lecture notes]. Retrieved from D2L site: https://d2l.ucalgary.ca.
8 Masuko, K., Shigematsu, M., Hashiguchi, T., Fujishima, D., Kai, M., Yoshimura, N., ... & Yamanishi, T. (2014). Achievement of more than 25% conversion efficiency with crystalline silicon heterojunction solar cell. IEEE Journal of Photovoltaics, 4(6), 1433-1435.
9 Mills, J. M. (2020 April). Bill 12 – Proposed changes to the Orphan Well Association to keep industry jobs and protect the Environment. BOE Report. Accessed April 15, 2020. https://boereport.com/2020/04/02/bill-12-proposed-changes-to-the-orphan-well-association-to-keep-jobs-and-protect-the-environment/
10 Northern Alberta Geothermal Potential Mapping Project – Final Report. (February 2019).
11 State, Can. 2012. Statistics Canada Catalogue no. 98-310-X2011001. Ottawa, Ontario. Data products, 2016 Census.
12 State, Can. 2012. Statistics Canada Catalogue no. 98-310-X2011001. Ottawa, Ontario. Data products, 2016 Census.
13 Wu, Tianyi, et al. (2019). Numerical evaluation of building heating potential from a co-and closed-loop geothermal system using wellbore-reservoir coupling numerical model. Energy Exploration & Exploitation: 0144598718809796.

We would like to extend our gratitude to the Ft. MacKay , Samson Cree and Alexis First Nations for meaningful discussions, and to Dr. Maurice B Dusseault, and Dr. Jennifer Winter for supervising our work. Thank you as well to ACLES, the OWA and other industry partners for data collaboration. Thanks also to Dr. Celia Kennedy for her guidance.

[1] Faculty of Science, Geoscience, University of Calgary, Calgary, Alberta Canada T2N 1N4: Tel +1 403 990 7435; slalexan@ucalgary.ca
[2] Schulich School of Engineering, University of Calgary, Calgary, Alberta, Canada T2N 1N4: Tel.: +1 587-888-9747; jiujie.cai@ucalgary.ca
[3] The School of Public Policy, University of Calgary, Calgary, Alberta, Canada T2N 1N4; Tel.: +1 403-861-9494; ljflinkf@ucalgary.ca
[4] Civil and Environmental Engineering, University of Waterloo, Waterloo, Ontario N2L 3G1; Tel.: +1 519 729 8907; li.li.2@uwaterloo.ca