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

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Summary

The objective of this study is to create a new evaluation system to rank orphan wells for potential reuse or "upcycling opportunities." In Alberta, wells become "orphaned" when they no longer have a financially accountable owner. They become the responsibility of the Orphan Well Association (OWA) when there is no longer a legally or financially responsible party that can be held accountable to manage them effectively. The most recent economic downturn has resulted in the OWA reviewing thousands of well locations in Alberta and prioritizing their efforts based on cost efficiency and public safety requirements.[1]

The objectives to achieve this goal are:

(1) investigate the range of potential repurposing applications of orphan wells– based on technical criteria for wells with specific conditions; (2), derive criteria for evaluation and develop a new ranking system based on findings; (3) evaluate a sample set of orphan wells using the new criteria and ranking system; (4) conduct an analysis of potential applications; and (5) apply the new criteria to two case studies to demonstrate its effectiveness. In addition to the repurposing of existing orphan wells, a benefit to this study is its potential to impact considerations for future well construction. In the long-term, construction of production wells could lead to multi-purpose application of enhanced recovery, carbon capture and storage, geothermal, compressed air energy storage, mineral mining, and waste disposal alongside traditional use.

Introduction

Orphan wells refer to oil and gas wells taken out of production, often based on financial, environmental, or other considerations, including policy changes. Orphan wells that leak may cause environmental issues resulting from fugitive gas emissions (often methane) to the atmosphere and the groundwater. The number of orphan wells registered in Alberta increased by approximately 4500% between 2012-2019, while the number of wells reclaimed decreased by approximately 50% between 2016-2019. The cause of the decline is mainly economic, with an average cost of $34,000 per decommissioned well reported by the OWA in 2018.[2]

A levy system managed by the Alberta Energy Regulator (AER) provides funding to the OWA. The levy system has not been able to support the increasing cost of orphan well liabilities. This study aims to change the perception of existing orphan wells as potential assets rather than liabilities.

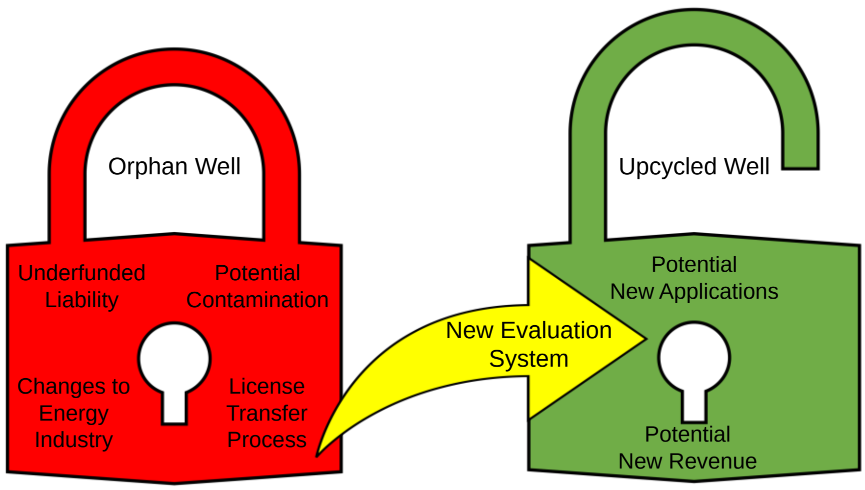

Figure 1: Developing a new evaluation system that unlocks future opportunities for orphan wells.

Reusing wellbores and depleted reservoirs are not a new idea, especially in the field of fluid injection. Wellbore integrity for deep wells used for CO_2 capture and storage was studied in the basal Cambrian system previously.[3] However, combining repurposing options and forming an evaluation system for orphan wells is novel. The technical specifications of selected wells could be used to essentially triage and rank them for new applications. Repurposing wellbores could decrease the number of orphan wells.

Method and Workflow

This study examines data collected from the OWA and the AER using GeoScout™ (version 8.13, GeoLOGIC Systems) to establish an accurate range of variability in existing well specifications upon which to base the evaluation criteria. Case studies of two orphan wells test for potential risks and outcomes of the new evaluation system.

(1) **Analysis of existing public domain data,** including well depth, formations intercepted, geographic location, gas migration and vent flow status and wellbore integrity.

(2) **Classification for Repurposing**. Based on specifications, wells are classified numerically. Category ranking matches the potential application, including:

(a) **Continue to be an oil production well**. Well might be inactive but can be reactivated when a viable company acquires its licence through the AER.

(b) **Enhanced Recovery (EOR)**. Well is injected with fluids consisting of brine, fresh water, steam, polymers, or carbon dioxide[4][5] to recover residual oil (possibly at untapped elevations) and in limited applications, natural gas.

(c) **Carbon Capture and Storage (CCS).** Well is injected with carbon dioxide (CO_2) into deep rock formations to conduct CO_2 geological sequestration to mitigate the effects of global warming. [6]

(d) **Geothermal Conversion**. Depleted well, with a bottom-hole temperature of at least 65°C, is converted for geothermal use. [7]

(e) **Compressed Air Energy Storage (CAES)**. Considered a potential technology to conduct renewable energy (solar or wind), CAES uses electricity to drive air compressors to compress the air to a higher pressure and store the energy in an internal form in reservoirs or wellbores when the electricity system load is low. Later, the high-pressure air is released to drive air engines (expanders) or natural gas turbines to meet electricity demand (when the demand for electricity is high) and can be combined with geothermal to achieve high efficiency.[8]

(f) **Mineral Mining.** Well is injected with fluids to dissolve and extract minerals, such as uranium, salt, copper and sulphur. [9]

(g) **Waste Disposal.** Disposal wells exhibit optimum environmental conditions, to responsibly inject hazardous and non-hazardous wastes into deep, confined rock formations.[10] [11]

Novel/Additive Information

Today, there are 90,000 inactive wells in Alberta, that are vulnerable to becoming orphan wells due to economic challenges faced by licence holders associated with production maintenance or responsible abandonment. Repurposing of existing wells and modification of construction specifications of 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 alternative uses such as CCS, geothermal, waste deposition or an injection well for EOR. The application of the evaluation system introduced in this study advances our knowledge of the economic and environmental benefits of repurposing wells. This information is pivotal in defining necessary updates to existing policies and regulations.

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