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Reducing methane emissions from documented abandoned and orphaned oil and gas wells in Canada and in the United States

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Abstract : Millions of oil and gas wells are abandoned and orphaned around the world. Due to funding shortfalls, many abandoned and orphaned wells remain unplugged and are negatively impacting the environment and contributing to greenhouse gas emissions, such as methane. To reduce emissions and environmental impacts, the wells are required to be plugged but the well sites can be repurposed for wind and solar energy and/or the wells itself can be redeveloped for geothermal energy production. To quantify methane emissions and identify opportunities for repurposing abandoned and orphaned wells and well sites for renewable energy development, we analyze public oil and gas well data from governmental agencies of documented abandoned and orphaned wells in Canada and the United States. We estimate the total number of abandoned and orphaned wells in Canada and the United States to be 3,500,602, of which 4% are orphaned and in need of government funding. We estimate plugging costs for orphaned wells in the United States to exceed federal funding by 33%-80%. For abandoned and orphaned wells, we quantify methane emissions at the national and state/provincial/territorial level and potential emission reductions achieved through plugging. Furthermore, to evaluate mitigation and redevelopment opportunities, we analyze geographic locations of abandoned and orphaned wells with national maps of renewable energy potential (geothermal, wind, and solar) and land cover/land use in Canada and the United States. Mitigating oil and gas wells can help fulfill national energy transition goals and emission reduction targets, while providing an additional funding stream to manage the millions of abandoned and orphaned wells around the world.

Keywords : Methane, oil and gas wells, abandoned wells, orphaned wells, renewable energy

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1 Introduction

Abandoned and orphaned oil and gas wells are non-producing wells. They can emit methane, a potent greenhouse gas, and other air pollutants, contaminate groundwater and surface water, degrade ecosystems, and impact human health.

To limit these environmental and climate risks, plugging and remediation is needed, but can be expensive, leaving many abandoned and orphaned wells unplugged.

Abandoned/orphaned wells and well sites may be repurposed for solar, wind, or geothermal energy production. Some of the benefits include:

- Reduce costs of renewable energy deployment (reusing infrastructures and land acquisition/leasing)
- Incentivize well plugging and remediation
- Preserve undeveloped lands that would have otherwise been used for renewable energy development

Research to characterize abandoned and orphaned wells is needed to:

- Reduce methane emissions and other environmental impacts
- Prioritize wells for mitigation
- Repurpose wells and well sites to renewable energy production

Data on abandoned and orphaned wells is needed to inform policies and regulations, such as:

- Optimize federal spending and regulations
- Meet national energy transition goals and emission reduction targets

2 Methodology

Here, we focus on "documented" abandoned and orphaned wells, which are recorded by governmental oil and gas agencies. There are likely many more abandoned and orphaned wells that are undocumented (not currently included in government databases).

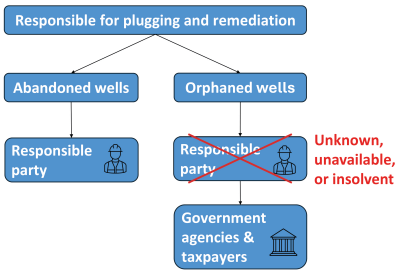
Number, well location, and well depth compiled from public state, provincial, and territorial databases across Canada and the U.S. and quality controlled/checked [1].

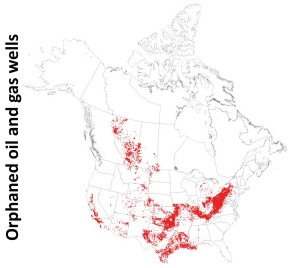
Oil and gas regulatory agencies across Canada and the U.S. contacted when information unavailable in public databases.

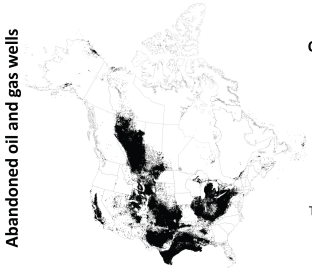
Documented orphaned well definitions and content of state oil and gas well databases vary across states, provinces, and territories making it challenging to compile a continental-scale geospatial dataset. There are many documented abandoned and orphaned wells across Canada and the U.S., but their attributes are scantily documented in governmental databases.

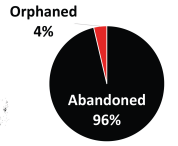
To estimate renewable energy potential, we analyze geographic locations of abandoned and orphaned wells with national maps of land cover/land use and wind, solar and geothermal energy potential.

3 3,500,000 documented abandoned and orphaned oil and gas wells in Canada and the US



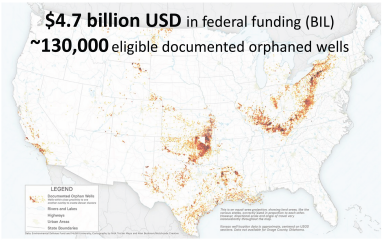


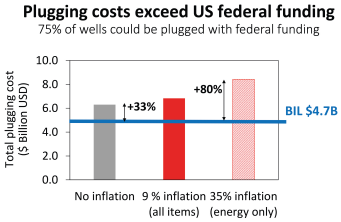




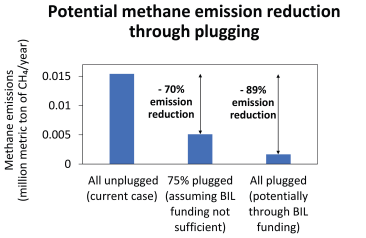
There are likely ~100,000s to ~1,000,000s undocumented oil and gas wells across Canada and the US.

4 US documented orphaned oil and gas wells





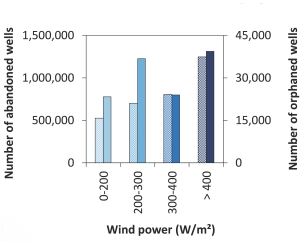
Plugging costs model considers documented orphaned well age and well depth and includes surface clean up and remediation/restoration costs.[10]

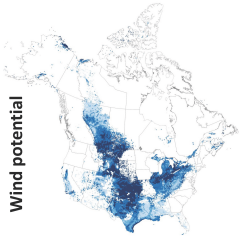


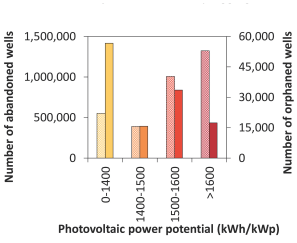
Emission factors from Williams et al. (2021) that consider well type (e.g., oil and/or gas).[10]

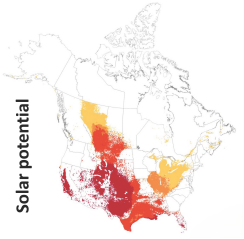
5 Additional funding stream for mitigation and incentive for methane reduction

Converting abandoned and orphaned wells to solar, wind, or geothermal energy production can provide an additional funding stream to repurpose the land, remove and restore existing infrastructures, and plug the wells, all of which provide environmental benefits, stimulate the economy, and incentivize plugging and remediation.

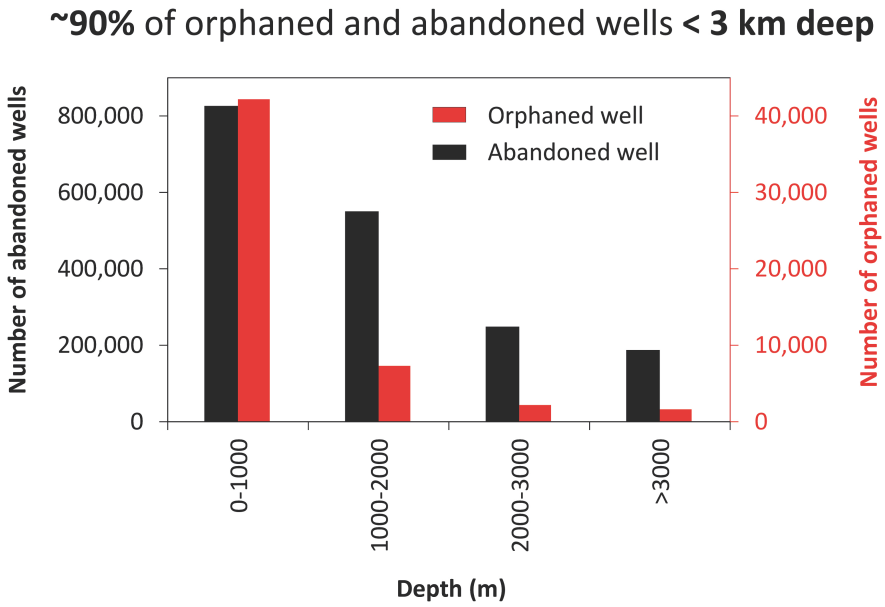




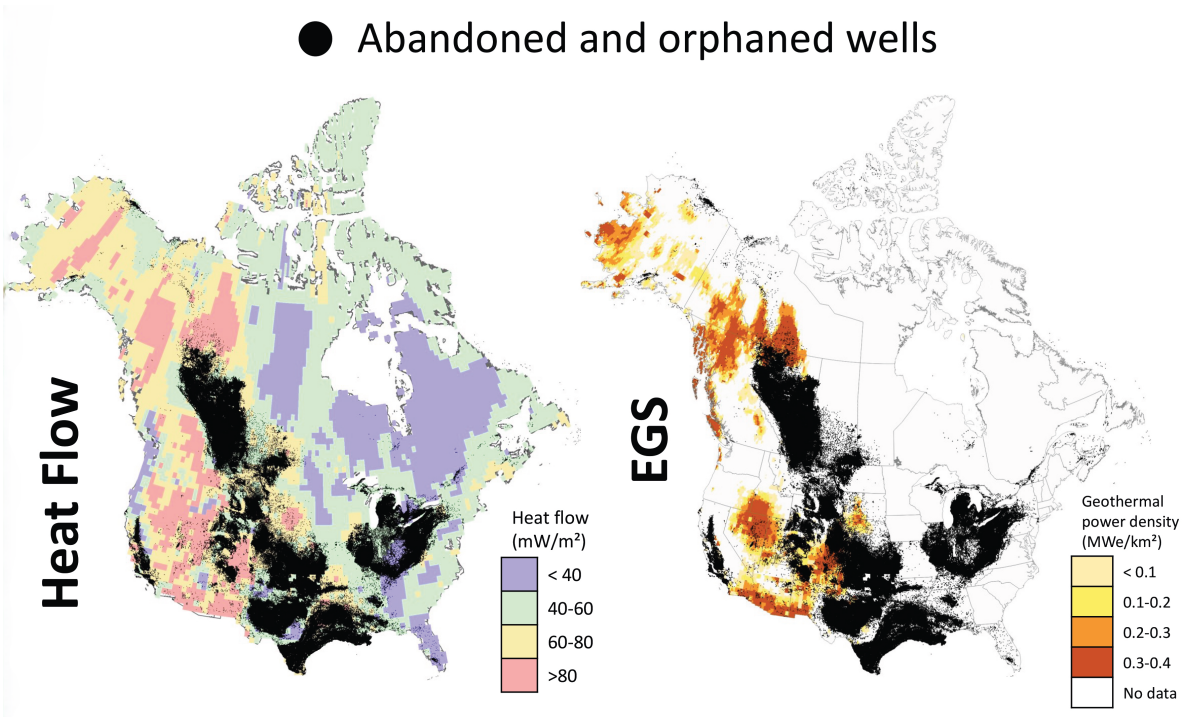




6 Geothermal potential

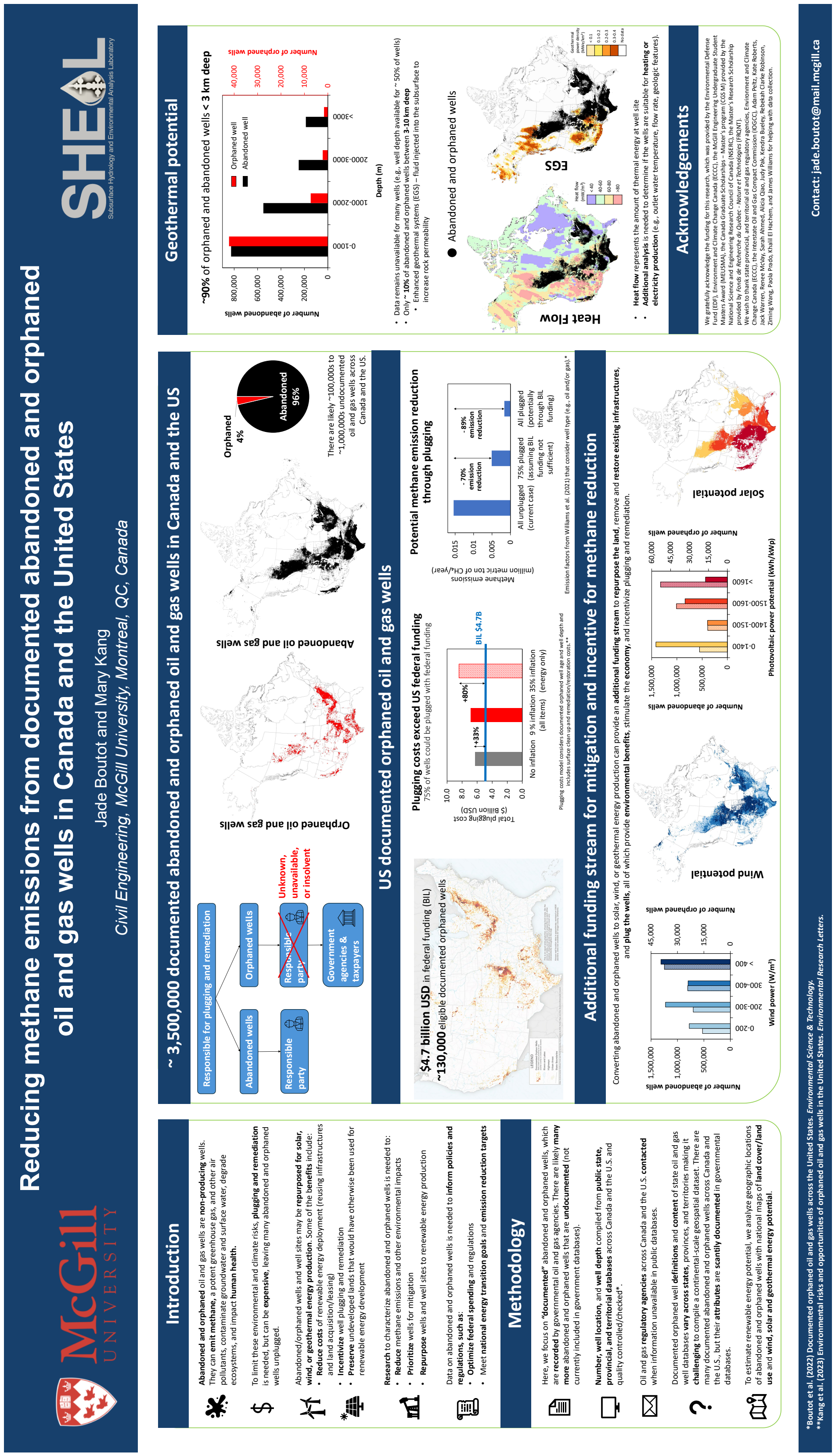


- Data remains unavailable for many wells (e.g., well depth available for 50% of wells)
- Only 10% of abandoned and orphaned wells between 3-10 km deep
  - Enhanced geothermal systems (EGS) – fluid injected into the subsurface to increase rock permeability



- Heat flow represents the amount of thermal energy at well site
- Additional analysis is needed to determine if the wells are suitable for heating or electricity production (e.g., outlet water temperature, flow rate, geologic features).

7 Poster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SHEAL
Introduction
Methodology
~ 3,500,000 documented abandoned and orphaned oil and gas wells in Canada and the US
Responsible for plugging and remediation
Abandoned wells
Orphaned wells
Responsible party
Unknown, unavailable, or insolvent
Government agencies & taxpayers
Orphaned oil and gas wells
Abandoned oil and gas wells
Orphaned 4%
Abandoned 96%
US documented orphaned oil and gas wells
$4.7 billion USD in federal funding (BIL)
~130,000 eligible documented orphaned wells
Plugging costs exceed US federal funding
Potential methane emission reduction through plugging
Additional funding stream for mitigation and incentive for methane reduction
Wind potential
Solar potential
Geothermal potential
~90% of orphaned and abandoned wells < 3 km deep
Heat Flow
EGS
Abandoned and orphaned wells
Acknowledgements
Contact: jade.boutot@mail.mcgill.ca

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[1] Jade Boutot, Adam S. Peltz, Renee McVay and Mary Kang (2022) Documented orphaned oil and gas wells across the United States. *Environmental Science & Technology*. 56(20):14228–14236. DOI: 10.1021/acs.est.2c03268.

[2] Mary Kang, Jade Boutot, REnee C. McVay, Katherine A. Roberts, Scott Jasechko, Debra Perrone, Tao Wen, Greg Lackey, Daniel Raimi, Dominic C. Digiulio, Seth B. C. Shonkoff, J. William Carey, Elise G. Elliott, Donna J. Vorhees and Adam S. Peltz (2023) Environmental risks and opportunities of orphaned oil and gas wells in the United States. *Environmental Research Letters*. 18 074012. DOI: 10.1088/1748-9326/acdae7.