

Summary

This Roadmap outlines a plan to advance ultradeep geothermal power—that is, geothermal systems with depths greater than 5 km—to commercial operation in Canada. Intended for policymakers, geothermal developers, technology companies, and investors, it identifies the most promising opportunities and priorities for technology, policy, and regulation; highlights key gaps; and provides guidance for how public and private investment can support efforts to rapidly close these gaps.

Canada’s world-class expertise and human capital in subsurface resource development (specifically in the design, drilling, and completion of oil and gas wells) is a relatively untapped competitive advantage that could be harnessed to launch Canada into the global race to develop and commercialize **ultradeep geothermal systems**—while unlocking geothermal resources at shallower depths along the way. This Roadmap provides recommendations for how to accelerate R&D and testing, coordinate stakeholders, fill policy and regulatory gaps, and de-risk the industry.

Advantages of ultradeep geothermal power

Ultradeep geothermal power has several advantages over other low- and zero-carbon energy systems. For example, geothermal power could:

- provide the massive amount of zero-emission baseload and dispatchable power that we need to meet our emission reduction targets and help integrate intermittent renewables into grids;
- reduce land requirements due to the small footprint of surface facilities;
- be deployed in urban centres, rural communities, retrofitted power stations, and where electricity load demands are high, reducing the need for extensive transmission lines;
- take advantage of existing subsurface resource development processes and technologies, creating jobs that match the existing skills and expertise in the oil and gas sector; and
- provide other climate solutions, including zero-carbon heat production, carbon dioxide sequestration, and energy storage.

Ultradeep geothermal potential in Canada

Tapping just one percent of the geothermal heat resource between 4 and 7.5 km depth in Canada could conservatively generate 77 GW of power (equivalent to half of Canada's 2021 installed generating capacity).

Highest-priority technology gaps

Ultradeep geothermal's four main technological challenges are:

- 1.Reduce drilling time:** To drill faster—and therefore cheaper—in hard rock (crystalline igneous and metamorphic rock), we need to improve drilling methods and drill bit longevity.
- 2.Develop high-temperature downhole tools and advanced temperature management technologies:** The deeper the well, the hotter it gets. To contend with the extreme temperatures and pressures of ultradeep geothermal drilling, we require downhole tools with higher temperature ratings and better temperature management technologies to create a cooler environment within the well during drilling.
- 3.Improve well-completion technologies:** Well-completion components such as cement and well casings need to handle high temperatures and last for >40 years.
- 4.Improve heat extraction methods:** Heat extraction methods for both open-loop and closed-loop systems must be optimized for heat recovery at increasing depths, pressures and temperatures.

Highest-priority policy and regulatory gaps

The top three policy and regulatory challenges for geothermal systems (of all types and depths) are:

- 1.Address lack of regulatory frameworks and rules for permitting and rights/tenure:** Currently, only three Canadian provinces have regulatory frameworks that specifically address geothermal (Alberta, British Columbia, and Nova Scotia). These frameworks must be expanded and improved—and new regulations, permitting procedures, and tenure rules must be developed in other Canadian jurisdictions.
- 2.Harmonize and streamline policy across jurisdictions:** Existing geothermal policy in Canada is inconsistent and fragmented across jurisdictions, creating unnecessary complexity leading to investment and development risk.
- 3.Create cohesive messaging on geothermal policy:** The lack of a unified voice creates confusion for potential funders and policymakers.

A Canadian geothermal innovation ecosystem would vault Canada to a world-leading position in what is poised to be an essential future energy technology.



Four connected experimental sites

at established geothermal locations in Western Canada would share data and lessons to accelerate innovation and decrease risk.



Federal and university labs

would rapidly conduct *applied* research and analysis, catalyzing advances in the field.

