

Horizontal Drilling for Geothermal Power Generation in the Williston Basin (Canada)

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Summary

The DEEP Earth Energy Production Corp. (“DEEP”) geothermal power project is located in Southeastern Saskatchewan, Canada, a few kilometres north of the United States border within the Williston Basin. Successful geothermal resource exploration in a hot sedimentary aquifer (HSA) requires two main contributing factors: hot fluid in permeable rocks and high well productivity. Modern well design has made sweeping the heat from the reservoir possible. DEEP developed a unique geothermal field design to maximize flow rates and optimize an important regional geothermal resource. DEEP’s “ribcage” geothermal well field design is globally unique and may be a transformative application of modern oil and gas drilling, completions and stimulation design applied for the first time on a renewable energy project. The project is advancing with local world class oilfield expertise and redeploying that uniquely skilled workforce into a new clean energy industry for Canada.

Results, Observations, Conclusions

The DEEP Project is located over two geologic formations with high temperature brine, 120-125° Celsius (248-257° Fahrenheit) the Deadwood and Winnipeg. This naturally occurring subsurface heat source initiated the interest in harnessing the geothermal resource to help meet the region’s green energy power demand. The development plan has focused in on a higher porosity interval within the lower Deadwood Formation to access the hot subsurface brine from the reservoir.

Since 2018, DEEP has drilled the six deepest wells into the Canadian side of the Williston Basin, all more than 3,450 m (11,319 ft) deep. To maximize well productivity, DEEP drilled its first horizontal well in October 2020. This was the first horizontal fluid production well in the world to be drilled and hydraulically stimulated for the purposes of geothermal power generation. The horizontal well was drilled to a total measured depth of 5,672 m (18,609 ft) which includes a 2,000 m (6,562 ft) horizontal section. It was completed with a cemented liner and a 20-stage multicycle stimulation sleeve system, and hydraulically stimulated using the latest horizontal well techniques. Extended testing of the geothermal system was completed in March 2021, producing from the horizontal well and injecting into previously drilled vertical wells. This large volume production and injection loop test was required to refine the reservoir model, lateral well lengths and well spacing for the horizontal well field layout.

Stratigraphic correlation and mapping of the basal Deadwood clastics showed a continuous sandstone depositional and temperature fairway capable of supporting numerous 20 MW Binary power projects by the utilization of multiple arrays of horizontal wells. Positioned in an east-west well orientation the first development array will consist of 10 production wells and 8 injection wells. The wells will be drilled from 3 surface pads, each pad located approximately 2.25 kms (1.4 miles) apart. All pads will be connected by a production and injection pipeline system. Brine will be pumped from producer wells to the surface at approximately 120° Celsius (248° Fahrenheit). The

produced brine commingles in a 24-inch header before being delivered to an Organic Rankine Cycle Plant (ORC) where the heat is converted to electrical power.

Acknowledgements

DEEP gratefully acknowledges the continued support from Natural Resources Canada for the funding announced in 2019 and for their ongoing support in the development of Canada's first geothermal power project. By re-deploying world class oilfield expertise on a renewable energy project for the first time in Canada, this Federal funding is providing employment opportunities in a sector hard hit by job losses. New opportunities created from this geothermal power project, such as heating for greenhouses and aquaculture (fish farming), will be a welcome economic boost for the province.

We are also grateful to the Government of Saskatchewan for their continued support for the energy industry in the province. With their support, DEEP's innovative clean energy project will demonstrate sustainable power for Saskatchewan, making progress on its emissions reduction goals. Like many other energy projects, progress on DEEP's geothermal power project would not have gone forward without the support and guidance from the Ministry of Energy and Resources, the Ministry of Environment and SaskPower. Working together, regulatory and permitting processes for geothermal energy were developed, facilitating progress on geothermal power production and innovative uses of geothermal heat for sustainable food growing opportunities.

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