GETTING INTO...
HOT WATER

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INTRODUCTION

A drilling derrick juts up from amongst the harvested prairie fields in the northern portion of the Williston Basin. Its drill bit has sunk 10,000 feet (3,050 m) into the underground rock formations and will soon kick off from vertical and continue onward in a horizontal leg to the west. Highly skilled oil and gas workers perform their tasks with precision, grateful for this opportunity to work. It's the fall of 2020, and elsewhere drill crews are being idled as a glut of oil takes shape due to the sudden drop in economic activity across the globe, but this crew is not targeting a bench of the Bakken, in fact, they are not drilling for crude oil at all. They are drilling for water from a deep, hot aquifer at the base of the sedimentary basin, to mine its heat.

ADDING RENEWABLE ENERGY TO THE GRID

The company behind the project, DEEP Earth Energy Production Corp. (DEEP), was formed in 2010 and undertook its first drilling and testing phase in 2018, southwest of Estevan, Saskatchewan, and only 2 miles (3.2 km) from the border of North Dakota. Initially, their vision was to develop geothermal power facilities capable of supplying 100 to 200 megawatts of power from a series of small, repeatable 5-10 megawatt (MW) plants. The water comes from the Deadwood Formation, sitting atop the Precambrian basement, as well as the Winnipeg Formation (U.S. equivalent Black Island Formation) with the overlying Icebox Formation acting as a caprock and heat insulator (Zinchuk, 2018). Their testing has recorded water temperatures up to 261°F (127°C) from this aquifer. With the deepest portion of the Williston Basin located in North Dakota, even higher water temperatures can be expected in the state. The NDGS has recorded temperatures of 297 and 299°F (147 and 148°C) at depths of approximately 13,000 feet (3,962 m) within the Interlake and Stony Mountain Formations, respectively, in McKenzie County (McDonald, 2015). These temperatures were obtained 1,700 to 1,800 feet (518 to 549 m) above the Deadwood Formation at those locations.

Like wind, solar, and hydroelectric power generation, geothermal energy is renewable and produces zero emissions. Unlike other renewables, apart from hydroelectric, geothermal provides reliable baseload power, meaning it can generate and send power to the electric grid 24 hours a day. It also has a smaller surface footprint and does not interfere with wildlife migration patterns. While initial costs of construction are higher for geothermal energy facilities, over time they are competitive, with lower operating and maintenance costs.

The plant will operate using an Organic Rankine Cycle generator. Production wells will bring geothermal fluid up to pass through a heat exchanger where heat is transferred to a working fluid, like butane, which vaporizes, expands, and turns a power-generating turbine. The working fluid, contained in a closed loop, condenses as it cools and is re-used. The geothermal fluid is injected back into the aquifer to maintain pressure while absorbing more heat from the sandstone it passes through on a slow route back toward the production well (fig. 1).

Testing of this aquifer has shown much of the produced brine is sourced from a fractured reservoir system. Hydraulic stimulation and production modeling indicate commercial production rates of 26.5 gallons (100 liters) per second can be sustained. According to DEEP, the main constraints to production and injection rates are well design and pump size (Deep Corp., 2020).

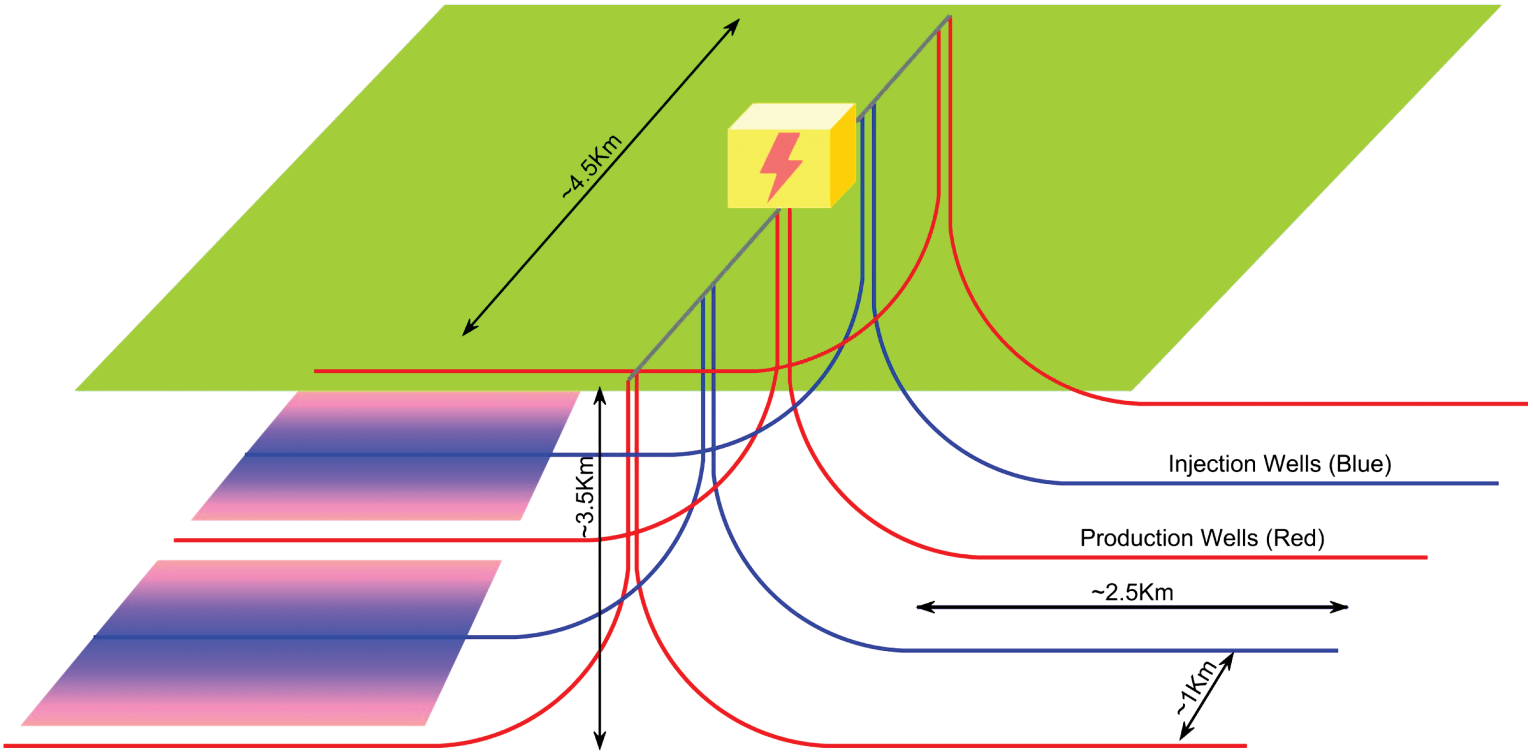

FIGURE 1.
Illustration of a preliminary design of a 10-well, 20 MW plant, modified from RESPEC. The horizontal wells on the left show injected water gaining heat as it percolates through the rock toward the production wells. New designs for a higher-capacity plant include more wells with longer lateral sections.

The flow rates observed thus far have led DEEP to increase their plant energy output estimates from 5-10 MW to 35 MW using 34 horizontal wells – consisting of 18 production and 16 injection wells. The subsurface development will be drilled and completed at the surface facility location along with four additional drilling pads and is planned to begin operation in early 2025. This would be stage one of an envisioned four-stage build of 35 MW plants, a scale-up that would provide 140 MW of power to the Canadian energy grid (Pipeline Online, 2022). Thirty-five MW is roughly the amount of energy needed to supply 35,000 homes and 140 MW would supply 140,000 homes.

There are also some potential synergies to be found. Regional waste flare gas could be captured and used to help power the plant's parasitic load, the energy draw required by the geothermal facility itself which would otherwise cut into the amount of energy supplied to the grid. Left-over heat in the water, approximately 149°F (65°C) as it exits the heat exchanger, could be used for greenhouses or other applications. Before injection back into the aquifer, this water could also be processed for rare earth and other critical mineral extraction, inviting the potential for partnerships with other mineral development companies.

Early on, the project received $175,000 from the government of Saskatchewan and another $1.3 million from Natural Resources Canada, put toward test drilling, to increase the percentage of renewable-sourced energy in the province's overall power supply. There was also an early power purchase agreement signed with SaskPower which helped attract private investments. Subsequently, the Government of Canada announced $25.6 million in funding for the plant in 2019. If successfully implemented, this work will move SaskPower closer to its goal of 50% renewable power generation by 2030.

There was an interesting, symbiotic dynamic between geothermal and oil and gas development which occurred at the early stages of DEEP's drilling and testing in 2020. In the face of a historic oil and gas downturn, DEEP was able to use equipment and employ crews that may have otherwise left the service sector and region, keeping them available for when the oil and gas climate returned to normal. DEEP CEO Kirsten Marcia, having many years of experience in the oil and gas industry, gives that industry due credit. She notes that DEEP is using oilfield data, technology, and processes to establish a renewable resource, which absent the industry, would not even be known to exist.

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