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Title: North Dakota Geothermal Energy

Abstract- Currently, active oil and gas wells produce approximately 10 Mbbls of water monthly from the Madison Group and Red River Formation in North Dakota. These formations are deep enough to have temperatures sufficient to produce nearly 1.5 MW of electrical power using only coproduced fluids. Comparison of pumping volumes for coproduced fluids with volumes from water flood sites in these formations suggests that pumping the wells for water raises electrical power production potential by 2 orders of magnitude. Today, technological advances in the development of scalable organic Rankine cycle (ORC) power plants makes the low-to-intermediate temperature (90 °C to 150 °C; 194 °F to 302 °F) geothermal waters that lie within sedimentary basins an attractive electrical power source. Until recently, ORC systems were available only on an at large scale, i.e., 10's of MW, and had efficiencies of about 10 percent. Currently there are at least five manufacturers making scalable ORC systems in the 50 kW to 1 MW range, and at least one system has an efficiency of about 17 percent and is expected to attain an efficiency in the low 20's as it is scaled up to produce power in the MW range. Values needed for these systems are temperatures of 92+ ºC and flow rates of 140-1000 gpm. The minimum temperature differential between the evaporator and condenser temperature for generating power economically is 120°F (65°C). The amount of power is dependent on both the temperature differential and the volumes of water (hot and cold). The mean annual temperature in North Dakota, which is essentially the ground temperature 2 m below the surface, remains around 50°F (10°C). Therefore, water produced at temperatures as low as 170°F (83°C) could produce electricity economically in all of the Williston Basin. To estimate the practicality of developing the resource, we used heat flow, bottom-hole temperatures, and measured temperature gradients to calculate the energy contained within specific formations having temperatures in the range of 100 ºC to 150 ºC. We found that at a 2% recovery factor, approximately 4500 MW can be recovered from heat stored at depths of 3-4 km. North Dakota currently produces approximately 3100 MW from non-renewable sources such as coal and petroleum. We conclude that the geothermal resource in the Williston Basin could completely replace fossil fuels as an electrical power supply for North Dakota.