Honorable Representatives of the State of North Dakota,

I am William D. Gosnold, Jr., Chester Fritz Distinguished Professor at the University of North Dakota in Grand Forks. I hold a bachelor's degree in physics with a minor in geology and a doctorate in geophysics. My research interests include heat flow from the Earth's interior, which finds applications in the thermal maturity of oil and gas, geothermal energy, and Earth's climate. I have collaborated with the US Department of Energy and state geological surveys to conduct geothermal resource assessments in North Dakota, South Dakota, Nebraska, and Minnesota. From 2010 to 2015, I partnered with scientists at Southern Methodist University, the Arizona Geological Survey, Texas Christian University, and the US Department of Energy to develop The National Geothermal Data System. The University of North Dakota has researched, compiled an outstanding database, and conducted numerous focused projects on developing North Dakota's geothermal resources with the support of excellent resources from the Oil and Gas Division of the North Dakota Industrial Commission and the North Dakota Geological Survey. The geothermal resources consist of hot water within the same sedimentary rocks that yield oil and gas, and the infrastructure required to harness geothermal energy is similar, if not identical, to that used for oil and gas production. The potential for geothermal energy development is vast, but this energy supply is renewable, unlike oil and gas.

The quantity of thermal energy stored in the Williston Basin is estimated to be 28 EJ (6.8 PWh), which exceeds the energy in oil and gas reserves in the Basin, i.e., 3.6 PJ (9.97 TWh) (EIA, 2020), by four orders of magnitude. One EJ (exajoule) is 10^{18} joule, and one PW (petawatt) is 10^{15} watts. Although a barrel of oil contains thousands of times more energy than a barrel of water at 150 °C, it can be produced only once. Geothermal heat mining at the scale we envision, with looping injection and production wells, can produce tens of barrels of water per minute. With good reservoir management, such a system can generate power for 20 to 30 years before new wells are needed. However, because the heat is conducted from the Earth's interior, a geothermal field will recover over time and can be redeveloped as a renewable resource.

In 2016, UND partnered with Continental Resources, Calnetix, and the US Department of Energy to demonstrate that geothermal electricity can be produced using oil-field infrastructure. Our analysis using the National Renewable Energy Laboratory (NREL) Cost of Renewable Electricity Spread Sheet (CREST) model found the cost to be $0.06 per kWh for that application. Using the existing infrastructure, there was no cost for exploration, drilling, or pumping. Including those costs raised the LCOE to $0.08 to $0.12 per kWh. The amount of electricity generated by the Calnetix machines was 250 KW. A later collaboration with the Swedish company Climeon found that their machine could generate 1 MW with the same fluid flow. My point is that technology is improving, and the cost of geothermal energy is decreasing.

I have two final points. The first is that electrical power and direct-use geothermal systems can be developed. Distributed geothermal power plants, with capacities ranging from 1 to 10 MW, can operate independently from the power grid and are safe from grid attacks. Using existing

technology, the direct use of geothermal energy for space heating can provide all of the state's heating and cooling needs.

The second point is that it will require a new industry. The petroleum industry is profitable in producing and selling oil and gas. Several oil companies have geothermal divisions, but their business primarily focuses on producing essential oil and gas. In 2016, I collaborated with scientists at NREL to address questions about why geothermal energy in the oil patch has not been developed. We identified that the challenges are economic, particularly concerning the economy of scale compared to petroleum and fossil fuel-based power plants.

Thank you for reading my comments supporting the development of geothermal energy. I welcome any questions and comments.

William D. Gosnold, Jr.
Chester Fritz Distinguished Professor
University of North Dakota