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Subcommittee on Energy
Hearing on "*Unearthing Innovation: The Future of Subsurface Science and Technology in the United States*"

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Thank you Chairman Williams, Ranking Member Bowman, and the Members of this Committee for the opportunity to be here today. My name is Ben Serrurier and I am the Government Affairs and Policy Manager at Fervo Energy, the leader in next-generation geothermal energy technology. We are developing enhanced geothermal (EGS) projects to deliver 24/7 clean electricity that leverages the drilling advances achieved in the natural gas industry over the last decade. Geothermal has a major role to play in the future electric grid by providing clean and reliable energy, and our key advancements in drilling and subsurface analytics bring a full suite of modern technology to make geothermal cost competitive.

New Technological Breakthrough: We Can Deploy Next-Generation Geothermal Today

The convening of this hearing happens at an opportune moment: last week, Fervo Energy announced a major technological breakthrough in next-generation geothermal energy development, proving that next generation geothermal energy is commercially viable and ready to scale.[1] Removing the remaining technical barriers to expanding geothermal puts America in the position to dominate the global market for this high potential clean energy resource.

Fervo is applying the techniques and technologies that were key to unlocking the American shale gas revolution, but have never before been applied to geothermal reservoirs. In May, Fervo completed a 30-day test of our commercial scale pilot project, called "Project Red," in northern Nevada. This successful well test confirms our system, the most productive enhanced geothermal system in history, is commercially ready. This breakthrough signifies the official commencement of what is likely to be yet another American-led energy revolution.

Geothermal energy is not novel: in both the United States and abroad, geothermal energy has been a source of reliable electricity for over half a century and used for heating and cooling for

[1]https://www.bloomberg.com/news/articles/2023-07-18/fervo-energy-says-it-has-achieved-geothermal-energy-tech-breakthrough

even longer. However, until now, its potential has been limited by our ability to find and tap only specific geologic formations. Despite significant advancements in reservoir characterization, subsurface monitoring and simulation, drilling, and well production – the fundamental drivers of geothermal cost and productivity – the approach to commercial geothermal power development has barely advanced at all.

Fervo's project data demonstrates that we have removed this limitation and opened up a new era in geothermal potential.

The important metrics for a successful geothermal project come down to flow rate and temperature. In other words, how much water you can produce from the well, and how much energy that water holds. Greater flowrates and higher temperatures result in greater power production.

Over 30 days, we flowed water through our reservoir as part of a standard geothermal exercise called a flow test. Through this test we achieved a flowrate of 63 liters per second at a temperature of 375°F, enabling 3.5 MW of electric production.[2] All of these data points set new records for output from an enhanced geothermal system, and are solidly within the expected range for successful commercial production.

We achieved this outcome by drilling a horizontal well pair and performing a multi-stage completion, and we installed fiber optic cables to monitor well performance and inform future optimization plans. Our horizontal well pair, the first and second horizontal wells to ever be drilled in a geothermal reservoir, reached a vertical depth of 7,700 ft before turning ninety degrees and extending another 3,250 feet each.

Our multi-stage well completion process was the second multi-stage high pressure completion with proppant to be pumped in a geothermal reservoir – the first was a pilot test Fervo ran in 2020 in an existing highly deviated well in the same field. All operations were accomplished safely and without incident.

While successful, this project is just a start. Data collected through the course of the pilot will enable rapid advancement in geothermal technology, and Fervo has already finished drilling its first well at a new field in southwest Utah. Now complete, this well is Fervo's fourth well drilled overall and the first on a project that will ultimately total over 400 MW and come online before the end of the decade.

[2] Norbeck, Jack; Latimer, Tim (2023): Commercial Scale Demonstration of a First of a Kind Enhanced Geothermal System. EarthArXiv. https://doi.org/10.31223/X52X0B

Over the course of drilling just four wells, we have seen an 18% performance improvement, demonstrating the powerful cost reduction achieved through deployment learning curves (see Figure 1). Late last year, the Department of Energy (DOE) launched the enhanced geothermal EarthShot with the goal of cutting the cost of EGS by 90% to $45 per megawatt hour (MWh) by 2035.[3] Fervo's RD&D roadmap includes reducing drilling time, reducing the complexity of completions, enhancing supply chain efficiency, and increasing reservoir optimization - our roadmap has already paved a clear path to achieving the EarthShot's goal ahead of schedule.

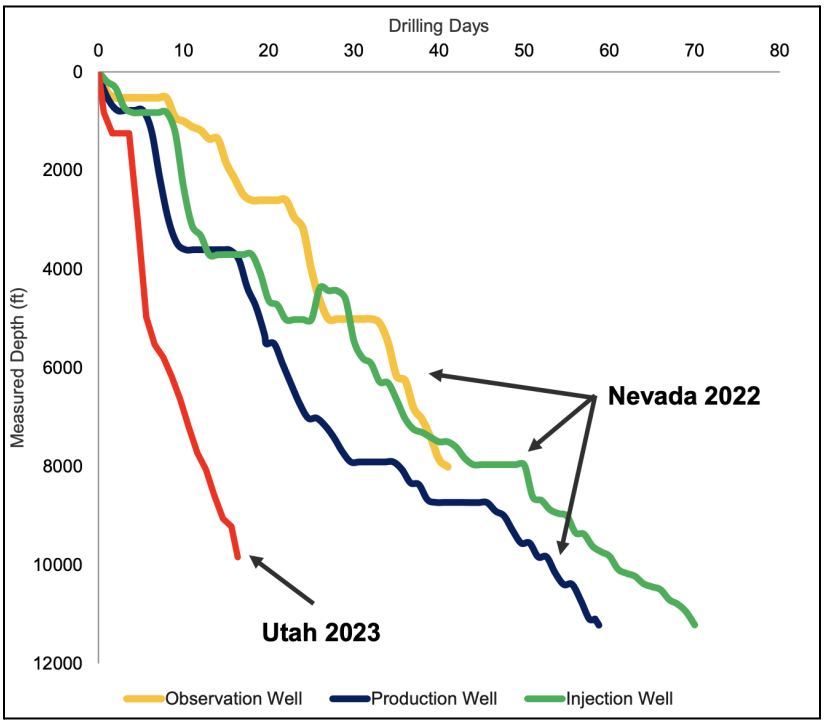

Figure 1: Fervo drilling productivity, demonstrating learning curve reduction in drilling days.

Our results from Project Red support the findings of the DOE Enhanced Geothermal EarthShot – that EGS is ready to scale and can supply over 20% of U.S. power needs as a critical piece of a reliable, fully decarbonized power grid. American-led innovation has removed the last remaining technological barriers to geothermal deployment, and we are charging ahead to achieve another step change growth in clean energy from the subsurface.

Federal Research, Development, Demonstration & Deployment (RDD&D) Investments in Next-Generation Geothermal Will Help Lower Costs Further

The breakthrough success of Project Red is the result of many years of reservoir modeling, pilot testing, and field construction; innumerable partnerships with universities, DOE and its National

[3] https://www.energy.gov/eere/geothermal/enhanced-geothermal-shot

Labs, and service companies; and the determined ingenuity of the Fervo team. Fervo's approach is adapted from technological developments from the shale gas revolution, one of the great technological innovation stories of the past few decades. Following the path blazed by the natural gas industry can point the way forward for the U.S. to become the global leader in geothermal.

America's abundant natural gas supply is the result of decades of dedicated research funding, strategic innovation programs and public-private partnerships spearheaded by DOE and other government agencies.[4] Together with industry partners, public investment in subsurface R&D developed the data, tools, techniques, and technologies necessary to access natural gas in shale formations. The critical components enabling the growth of the shale industry, including but not limited to reservoir simulation, well stimulation techniques, polycrystalline diamond compact drill bits, microseismic imaging, and directional drilling, were all developed by federal researchers, or with their close collaboration. Our ability to successfully develop enhanced geothermal projects follows directly from this long history of successful public investment in subsurface science and technology.

Innovation in the shale industry did not stop at simply proving the feasibility of these new technologies but continued through their demonstration and deployment. Over the past decade, America has completed hundreds of thousands of wells across a wide range of geologies. Each of these projects contributes to our collective understanding of shale formation behavior and drilling tools and techniques. Learning from this experience, the shale industry has optimized a manufacturing approach to well development – resulting in shorter drilling times, more efficient completion, and greater production per well. Like the natural gas industry a decade ago, geothermal is at a critical inflection point: Fervo has demonstrated the effectiveness of EGS technology, and we now have the opportunity to perfect it.

Fervo has worked closely with DOE and its National Labs to reach this point. Our co-founders were accepted into the Cyclotron Road fellowship program at Lawrence Berkeley National Lab to develop the initial idea for Fervo's approach to EGS and set up a Series A funding round led by some of the largest names in clean energy venture investing. In 2019, Fervo received a $1 million development grant from DOE, followed closely by a $1.2 million ARPA-E development grant, which helped us demonstrate the use of advanced fiber optic sensing and complete the first ever multi-stage well stimulation in a geothermal well. As our projects and company grew, we also increased our partnership with DOE; we received a $1.5 million exploration grant from DOE in 2020 and a $7 million development grant with DOE's Frontier Observatory for Research in Geothermal Energy (FORGE) in 2021. An ARPA-E OPEN award of $4.5 million in 2022 is providing critical backing to advance long duration in-reservoir energy storage capabilities to

[4] https://thebreakthrough.org/issues/energy/where-the-shale-gas-revolution-came-from

allow for load-following geothermal production.[5] The partnership between Fervo and DOE has helped push forward the science of geothermal energy while demonstrating the commercial importance of those new discoveries.

Revenue and learnings from Fervo's Nevada project will go toward the development of other projects in new geographies. This summer, Fervo broke ground on its first greenfield development in southwest Utah, adjacent to DOE's FORGE site. Following the subsurface breakthroughs that enabled shale, Fervo's Utah project will utilize a modular approach with standardized well design to increase drilling speed, reduce development costs, and bring EGS to scale.

Federal support for early-stage R&D has been critical to reaching this milestone, and federal support for demonstration and deployment will be just as important to sustaining progress. Historically, funding for geothermal has trailed far behind other clean firm energy technologies, despite its recent progress and large benefits per invested dollar (see Figure 2). To that end, we are eager for the DOE Geothermal Technologies Office (GTO) to invest its allocated funding from Fiscal Year 2023 appropriations for enhanced geothermal systems demonstration projects.

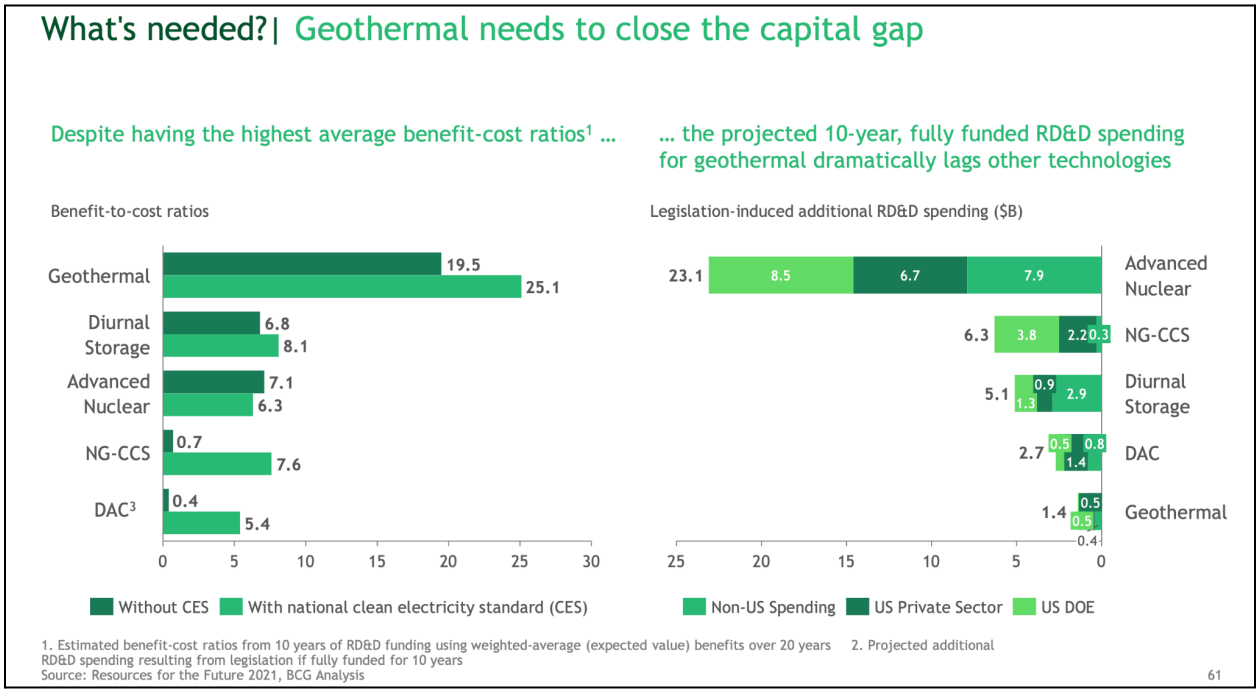

Figure 2: Energy technology spending and benefit-to-cost ratios (BCG 2023).

[5] Latimer, T., Ricks, W., & Jenkins, J. (2022). The value of in-reservoir energy storage for flexible dispatch of geothermal power. *Applied Energy*, *313*, 118807. https://doi.org/10.1016/j.apenergy.2022.118807

Next-Generation Geothermal Energy Provides 24/7 Clean Electricity, Enhances U.S. Energy Security, and Creates Jobs

The technical breakthrough in EGS comes at a critical time for the U.S. energy landscape. Capitalizing on the now-proven technical capabilities of EGS is necessary for the United States to meet its clean energy goals while safeguarding grid reliability, strengthening domestic energy security, and creating high-paying jobs in manufacturing and subsurface development.

As part of the ongoing energy transition, the United States will need more 24/7 clean electricity to meet growing demand from advanced computing and the electrification of vehicles, buildings, and industrial processes. The North American Electric Reliability Corporation (NERC) warns that large portions of the grid are at a "high risk" of capacity shortfalls through 2027, even under normal seasonal peak conditions.[6] At the same time, states, utilities and major corporations are increasing their calls for clean energy. EGS is the only next-generation clean, firm generation resource that has proven production under fully commercial conditions and can deploy today to meet tomorrow's challenges.

Geothermal energy is American energy. Utilizing domestic resources – literally the 'heat beneath our feet' – with American-made equipment and a homegrown workforce that pulls directly from America's world-leading oil and gas industry, geothermal energy is a complete energy security solution. America's steel mills are equipped to produce the advanced metals needed to withstand the harsh downhole conditions and our experienced drilling workers are ready to set new records for geothermal well execution.

While conventional geothermal resources are relatively limited, the subsurface heat resources that can be tapped with an EGS approach is inexhaustible. Analysis by DOE and the U.S. National Renewable Energy Laboratory (NREL) estimated that geothermal energy generation capacity could exceed 230 GW by 2050 and also found that the available geothermal resource is potentially orders of magnitude greater than that.[7] The successful EGS results from both Fervo and FORGE projects indicate that these prior studies are conservative. America's geothermal industry draws upon a resilient domestic supply chain and ready-skilled workforce to build a strong foundation of uninterruptible power.

While America is well-positioned to lead this geothermal revolution, other countries are catching up. In early 2023, the European Union announced a nearly $100 million grant to demonstrate a

[6] https://www.utilitydive.com/news/nerc-grid-resource-adequacy-shortfall-reliability-assessment/638949/
[7] Augustine, Chad, Sarah Fisher, Jonathan Ho, Ian Warren, and Erik Witter. 2023. Enhanced Geothermal Shot Analysis for the Geothermal Technologies Office. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5700-84822. https://www.nrel.gov/docs/fy23osti/84822.pdf.

next-generation geothermal project in Germany.[8] This single grant was $16 million more than the total investment the Bipartisan Infrastructure Law provided to divide across four U.S. geothermal projects. China's most recent Five Year Plan on Renewable Energy Development includes a prominent role for Chinese geothermal development and generation. A Chinese research team recently broke ground on a new deep-drilling project seeking to develop more advanced subsurface capabilities.[9]

The Boston Consulting Group estimates that globally, geothermal represents a $1.5 trillion market.[10] To capture the lion's share of this economic opportunity, America should consolidate its comparative advantages in subsurface technology, advanced manufacturing, and project development. Increasing investment in American EGS innovation and deployment will catalyze a wave of American-built geothermal across the globe.

Conclusion

The shale gas revolution has shown what is possible when the U.S. Federal government works with industry to invest in subsurface exploration. That journey of technological innovation, commercial entrepreneurship, economic abundance and energy security, is now continuing in geothermal. Enhanced Geothermal Systems are now proven. Optimizing this technology through standardization and modularity will deliver affordable and reliable clean energy, tens of thousands of high-paying jobs, and a globally significant American industry.

Thank you again for the opportunity to highlight our technological breakthroughs and share our experience on how important it is for the public and private sectors to work together to advance subsurface technology.

[8]https://www.bloomberg.com/press-releases/2023-03-09/eavor-s-next-generation-geothermal-project-awarded-91-6-million-grant-from-the-european-innovation-fund
[9]https://www.bloomberg.com/news/articles/2023-07-21/china-is-drilling-another-10-000-meter-hole-this-one-for-gas
[10] Karan Mistry, Nico deLuna, Tina Zuzek-Arden and Thomas Baker, "Two Paths to US Competitiveness in Clean Technologies," Boston Consulting Group. March, 2023:
https://thirdway.imgix.net/pdfs/override/Two-Paths-to-US-Competitiveness-in-Clean-Technologies-Report.pdf