Testimony for the Record

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FOR A HEARING ON

Examining Geothermal Energy Development

BEFORE THE
UNITED STATES SENATE
COMMITTEE ON ENERGY AND NATURAL RESOURCES

June 20, 2019
Washington, D.C.

Introduction

Chairman Murkowski, Ranking Member Manchin, and members of the Committee, thank you for the opportunity to discuss the opportunities and challenges of geothermal energy and the activities that the U.S. Department of Energy is undertaking to secure America's future through energy independence, scientific innovation, and national security.

The Geothermal Technologies Office and Geothermal Energy

The Geothermal Technologies Office (GTO), within DOE's Office of Energy Efficiency and Renewable Energy (EERE), conducts research and development (R&D) to reduce costs and risks associated with geothermal development by supporting innovative technologies that address key exploration and deployment barriers.

The United States is the world leader in installed geothermal capacity (3.8 gigawatt-electric (GW) nameplate capacity; 2.5 GW net summer capacity). As an always-on energy source that harnesses the earth's natural heat, geothermal energy provides baseload power with the flexibility to ramp on and off. Geothermal power plants can also provide essential grid services and operate in a load-following mode, helping to support reliability and flexibility in the U.S. grid and ultimately facilitate a diverse, secure energy mix.

Geothermal energy can be used in three technology areas: (1) generating electricity, (2) providing residential and commercial heating and cooling using geothermal heat pumps, and (3) direct-use applications that can provide district scale heating solutions as well as a wide array of commercial and industrial applications where process heating is required.

Geothermal is on a path to becoming a widely available renewable energy source, a "50-state" solution. As Secretary Perry said just last month, "There is enormous untapped potential for geothermal energy in the United States. Making geothermal more affordable can increase our energy options for a more diverse electricity generation mix and for innovative heating and cooling solutions for all Americans." This comment accompanied the release of the *GeoVision* report on May 30, 2019. We know there is more that geothermal can do for this country, and how to get there is outlined in the *GeoVision* report.

GeoVision Study & Results

I'm excited to share the results of the *GeoVision* report with you today and what it means for the future of geothermal.

The *GeoVision* analysis represents a multiyear collaboration among industry, academia, the National Laboratories, and federal agencies to evaluate the potential for different geothermal resources. The effort assessed opportunities to expand nationwide geothermal energy

deployment through 2050 by improving technologies, reducing costs, and addressing project development barriers such as long permitting timelines.

The study highlights the vast potential for geothermal energy in both the electric and non-electric sectors to 2050.

The *GeoVision* study explored three scenarios in the electric sector. Under the business as usual scenario, geothermal generation capacity grows to 6 GW by 2050, about double what is available today.

However, under the improved regulatory timeline scenario, geothermal capacity could more than double beyond business as usual, to 13 GW by 2050. Results indicate that reducing the timeline from first exploration to full power plant operations can have a strong impact on the amount of geothermal energy on the U.S. grid.

In the technology improvements scenario, geothermal can realize dramatic growth in geothermal electricity generation and potentially increase geothermal generation more than 26-fold from today's level—reaching 60 GW of installed capacity by 2050. This capacity would make up 3.7% of total U.S. installed capacity in 2050, and generate 8.5% of all U.S. electricity generation.

The *GeoVision* analysis also shows how geothermal can profoundly enhance heating and cooling solutions for American residential and commercial consumers through direct-use and heat-pump technologies. Technology improvements could enable more than 17,500 geothermal district-heating installations nationwide, up from the 21 installations in use today. Additionally, 28 million U.S. households could realize cost-effective heating and cooling solutions through the use of geothermal heat pumps, up from 2 million geothermal heat pumps currently installed.

The *GeoVision* analysis also examined economic benefits to the U.S. geothermal industry; investigated opportunities for desalination, critical materials recovery, and hybridization with other energy technologies for greater efficiencies and lower costs; and quantified potential environmental impacts of increased geothermal deployment.

Perhaps most critically, the *GeoVision* analysis includes a roadmap of actionable items for all geothermal stakeholders to reduce technology costs and speed up project-development timelines. This call to action outlines the opportunities and challenges that lie ahead for advancing geothermal development in the U.S. and includes four Action Areas:

1. Research related to resource assessments, improved site characterization, and key technology advancements;
2. Regulatory process optimization;
3. Maximizing full value of geothermal energy; and
4. Improved stakeholder collaboration.

Current Research

The *GeoVision* Roadmap is meant to serve as a guide that the collective geothermal community, including DOE, can use to allow the nation to harness the untapped potential offered by geothermal resources. DOE is already addressing many of these action areas with our current research portfolio. I'd like to highlight just a few of the activities spearheaded by our Geothermal Technologies Office.

Frontier Observatory for Research in Geothermal Energy (FORGE)

Our flagship initiative, the Frontier Observatory for Research in Geothermal Energy, FORGE, heads the list of activities to address the technology improvement needs called out in the *GeoVision* roadmap. FORGE is a dedicated site where scientists and engineers will be able to develop, test, and accelerate breakthroughs in enhanced geothermal system (EGS) technologies and techniques.

The FORGE initiative is now finishing the second of three phases. GTO selected the final site at Milford, Utah, with the University of Utah-led team, during Phase 2. The University of Utah-led FORGE team is fully instrumenting the site for surface and subsurface investigation, and bringing FORGE to full readiness for R&D technology testing and evaluation in preparation for one final stage gate. During the five-year Phase 3 – Technology Testing and Evaluation, slated to start this summer, FORGE funding will support tasks necessary for management and oversight of FORGE operations and annual competitive R&D solicitations open to the entire stakeholder community.

Efficient Drilling for Geothermal Energy (EDGE)

Early-stage R&D in drilling technologies presents an opportunity for innovation that can have a big impact in making new geothermal development more economical. Drilling operations can be up to 50% of the cost of geothermal development. Given that much of the drilling occurs in the early stages of a project, complications from drilling failures can lead to cascading consequences resulting in overall project failure. Enabling the geothermal industry to drill more efficiently will reduce both the risk and cost and can help spur industry to expand capacity in the near-term.

GTO solicited projects in FY 2018 to enable the geothermal industry to double the average penetration rate for a geothermal well and improve the industry standard drilling rate of 250 feet per day by 2025. GTO has funded 11 projects covering three research areas: (1) reducing non-drilling time, (2) advanced drilling technologies, and (3) innovative partnership models.

Play Fairway Analysis (PFA)

A major barrier to the development of the large geothermal resources in the United States is the difficulty in locating blind geothermal systems (i.e., systems with no obvious surface

expression), along with the great expense of exploratory drilling. GTO has made a priority of advancing the state of the art in exploring for blind hydrothermal systems, and key among these technologies is the concept of play fairway analysis. Already successfully used in the oil and gas sector, play fairway analysis can be a key tool for decision making in any exploration project. GTO's efforts to adapt play fairway methods for use in geothermal exploration, with the ultimate goal of quantifying and reducing risk in geothermal exploration, have been very successful to date.

The goal of GTO's Play Fairway Analysis is to use combinations of data sets to pinpoint high-grade potential drilling areas. The initiative, which will wrap up in early 2020, is comprised of three phases. Phase 1, a desktop analysis phase, supported 11 projects, including projects in Idaho, Utah, Oregon, Washington, Hawaii, Nevada, and New Mexico. Validation is key to reproducibility; reproducibility is the key to cost and risk reduction, and to industry adoption of new techniques. In the final, current phase of Play Fairway, GTO is funding validation drilling for five of these projects. Results are still being analyzed, but early indications show astounding successes at several of the sites.

Advanced Energy Storage Initiative (AESI)

GTO supports R&D in the Advanced Energy Storage Initiative as part of DOE's Grid Modernization Initiative. Energy storage is critical to advance a flexible, resilient electrical grid and expand affordable mobility options from a diverse suite of energy resources, including both the electric and the non-electric sectors.

Within AESI, GTO is supporting geothermal-related projects seeking to analyze power curtailment, enhance reservoir thermal energy storage, and improve dispatchability through ground source heating and cooling and hybrid technologies. These projects focus on opportunities for flexible generation, controllable loads, and new approaches to the broader concept of energy storage to increase energy reliability and resilience.

In the non-electric sector, a subset of advanced energy storage systems, Deep Direct-Use (DDU), which utilizes low temperature ($<150^0$C) geothermal resources, has the potential to lower the cost of heating and cooling for university campuses, industrial parks, and military installations across the entire U.S., as well as address more global energy storage and resilient grid needs. GTO is funding six DDU studies to determine the economic feasibility of these technologies in various regions around the country.

Other current GTO R&D

GTO is making significant strides in addressing additional R&D challenges and seeking innovative solutions for technology improvements, such as:

- Zonal Isolation for Geothermal Reservoirs – technologies that can target specific zones efficiently and predictably for creating extensive and optimized fracture networks

- Waterless Stimulation – investigating new stimulation methods applied to geothermal wellbores that do not use conventional water-based fluids to ease the demands for water for energy uses, especially in water-starved regions of the U.S.
- Machine Learning for Geothermal Energy – new analytical tools to boost exploration and development of geothermal resources, and to maximize the value of the rich datasets utilized in the geosciences
- Lost Circulation & State of Stress - improved technologies for understanding subsurface stress, as well as novel or improved means for dealing with lost circulation events are key to lowering the cost of accessing geothermal resources

Conclusion

Geothermal research is an integral component of the Department's applied energy research and development portfolio. Geothermal energy has great potential to address this country's needs for energy affordability, energy integration, and energy storage. We've made great strides in adding geothermal energy as part of the portfolio of affordable energy options, and we'll continue to do so with a strategic and targeted R&D portfolio to continue to strengthen our energy security and independence.

DOE is committed to working in partnership with industry, academia, national laboratories, and other federal agencies to support the next generation in geothermal R&D, while ensuring appropriate stewardship of taxpayer investments. I appreciate the opportunity to appear before this committee to discuss DOE's work in geothermal research and the *GeoVision* report. Thank you for your time.