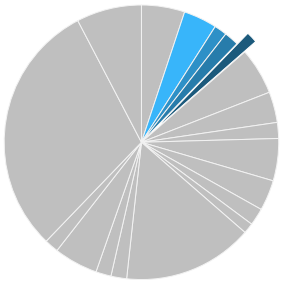
Federal Energy R&D: Geothermal Technologies

BY COLIN CUNLIFF AND BATT ODGEREL | MARCH 2020

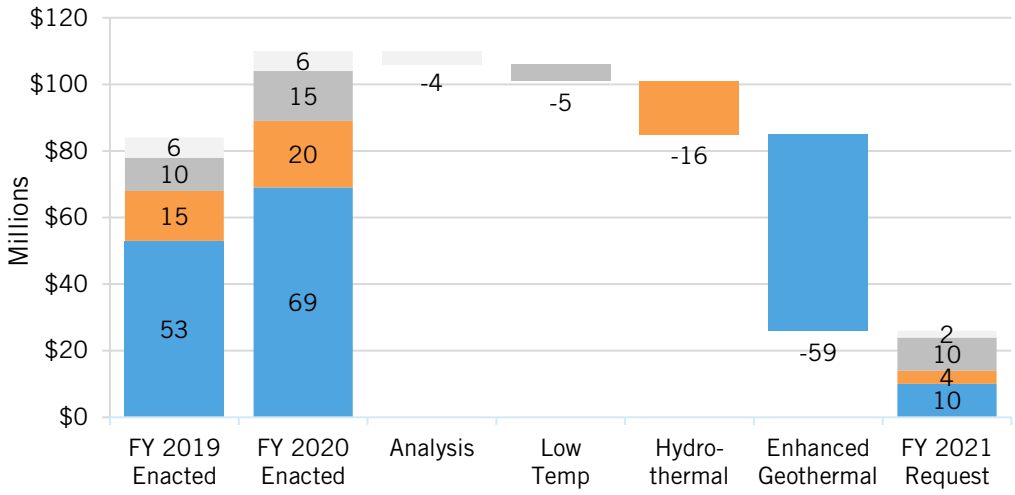
This briefing is part of a series on the U.S. energy budget. See: itif.org/energy-budget.



Geothermal (blue)
Other Renewables (blue)
Energy R&D (light grey)

Geothermal technologies use heat from the earth, either directly for such applications as heating and cooling, or to generate electricity with steam turbines. The Geothermal Technologies program supports research and development (R&D) of two main types of geothermal technologies: hydrothermal and Enhanced Geothermal Systems (EGS). Hydrothermal resources exist naturally in areas where there is sufficient temperature and permeability in the subsurface. EGS, on the other hand, requires rock stimulation for permeability enhancement and fluid injection to allow commercial-scale fluid flow that can be used for electricity generation.[1]

Figure 1: The FY 2021 budget request would cut geothermal R&D by 76 percent[2]



What's at Risk

In addition to the current U.S. installed capacity of geothermal energy of over 3.8 gigawatts (GW), there is a vast source of untapped energy just waiting to be realized. DOE's 2019 report *GeoVision: Harnessing the Heat Beneath Our Feet,* found that technological improvements and cost reductions could increase geothermal capacity to 60 GW by 2050.[3] The geothermal industry operates in a harsh subsurface environment in which unique technical and operational challenges must be overcome in order to realize this potential. Foremost among these challenges is the resources essentially being "out of sight" at a depth of anywhere from two to five kilometers, thus requiring new exploration technologies and tools to reduce the near-term costs and risk of development. The Department of Energy (DOE) set a goal of reducing the cost of electricity from enhanced

geothermal systems (EGS) to $0.06/kWh by 2050, which would make them competitive with other dispatchable baseload power.[4]

In addition, the United States has abundant low-temperature geothermal resources below 300 degrees F (150°C), with potential applications for residential and commercial heating and cooling, district heating and cooling, industrial process heating, and underground thermal energy storage. The *GeoVision* analysis found that the market potential for geothermal heat pumps is equivalent to supplying heating and cooling to 28 million households, which is 14 times more than the current installed capacity. Furthermore, district-heating geothermal systems could meet the heating and cooling demands of 45 million households in 2050.[5]

But realizing the enormous potential of America's domestic low-carbon geothermal resources requires R&D to harness them more effectively, develop improved methods to stimulate new resources, and characterize and model subsurface stress and other reservoir properties. Reductions in R&D funding threaten DOE's ability to take advantage of the most promising opportunities to advance geothermal technologies.

Geothermal Technologies R&D Subprograms

Geothermal R&D is divided into four subprograms:[6]

- **Enhanced Geothermal Systems (EGS)** explores materials and technologies to produce energy from man-made reservoirs that are otherwise not economical due to lack of water or permeability. Major initiatives include the EGS Collab, a small-scale field site in South Dakota for reservoir-model prediction and validation, and the Frontier Observatory for Research in Geothermal Energy (FORGE) site in Utah, a facility where industry and government researchers can test and validate innovative EGS technologies in a deep-rock environment.[7]

- **Hydrothermal R&D** focuses on technologies necessary to find and access "blind" conventional hydrothermal resources—or geothermal resources that require little-to-no stimulation to improve permeability and fluid flow, and are without clear surface expressions—by targeting innovative approaches to microhole drilling applications, self-healing cements, and subsurface imaging.

- **Low-Temperature and Coproduced Resources** targets research, development, and demonstration (RD&D) on technologies applicable to geothermal resources below a temperature of 300°F (150°C), including direct use of thermal resources for process and space-heating applications; hybrid power designs that can be codeveloped with existing well-field infrastructures; and geothermal-enabling technologies, including thermal desalination processes and thermal energy storage.

- **Data, Modeling, and Analysis** focuses on identifying and addressing barriers to geothermal adoption, as well as validating and assessing technical progress to inform the direction and prioritization of the portfolio. [8]

Key Elements of the FY 2021 Budget Proposal

- **No new funding for the Frontier Observatory for Research in Geothermal Energy (FORGE),** DOE's flagship geothermal research facility in Milford, Utah, aimed at developing and piloting EGS technologies. The FY 2021 budget proposal would operate FORGE through FY 2024 solely on previously-appropriated funding.

- **An 86 percent decrease in the EGS subprogram**, including the elimination of funding to design a seismic monitoring system; no new funding for FORGE pilot wells or near-field demonstration wells; and no funding for GEOTHERMICA, an international collaborative effort to advance EGS knowledge.

- **An 80 percent reduction in the Hydrothermal subprogram**, including no new funding for subsurface R&D to develop technologies to characterize and monitor subsurface stress; no new funding to apply machine learning to geophysical data; and no new funding for exploration RD&D to discover geothermal resources with no surface expression.

- **A 33 percent reduction in the Low Temperature subprogram,** including no new funding for geothermal district heating analysis; and no new funding to proceed with demonstration of a geothermal district heating system on a university campus.

- **A 67 percent decrease in the Data, Modeling, and Analysis subprogram**, including no new funding to continue the *GeoVision* nontechnical barriers study, which would build on the 2019 *GeoVision* report to evaluate opportunities to reduce geothermal soft costs.

ENDNOTES

1. U.S. Department of Energy (DOE), "FY 2021 Congressional Budget Justification" Volume 3 Part 1, 141–160 (DOE Chief Financial Officer DOE/CF-0163, February 2020), https://www.energy.gov/sites/prod/files/2020/02/f72/doe-fy2021-budget-volume-3-part-1.pdf.
2. DOE, "FY 2021 Congressional Budget Justification," Volume 3 Part 1, 143.
3. DOE, "GeoVision: Harnessing the Heat Beneath Our Feet" (DOE EERE, June 2019), p. xii. https://www.energy.gov/eere/geothermal/downloads/geovision-harnessing-heat-beneath-our-feet.
4. DOE's cost goal for geothermal systems is unclear. The "Fiscal Year 2017 Annual Performance Report/Fiscal Year 2019 Annual Performance Plan" states a goal of $0.06/kWh by 2030, which "includes both hydrothermal and Enhanced Geothermal Systems." However, the Fiscal Year 2021 Congressional Budget Justification states a goal of $0.06/kWh by 2050 "from newly developed enhanced geothermal systems." This cost goal in the FY 2021 Congressional Budget Justification appears to reflect a reduction in ambition. DOE, "Fiscal Year 2017 Annual Performance Report/Fiscal Year 2019 Annual Performance Plan," 82 (DOE/CF-0147) https://www.energy.gov/sites/prod/files/2018/11/f57/fy-2017-doe-annual-performance-report-fy-2019-annual-performance-plan.pdf; DOE, "FY 2021 Congressional Budget Justification," Volume 3 Part 1, 145-153.

5. DOE, "GeoVision: Harnessing the Heat Beneath Our Feet," p. xiii.
6. DOE, "Geothermal Technologies Office 2017 Annual Report," 3 (DOE EERE, January 2018) https://www.energy.gov/sites/prod/files/2018/01/f47/GTO%202017%20Annual%20Report.pdf; DOE, "FY 2021 Congressional Budget Justification" Volume 3 Part 1, 145–160.
7. Alexis McKittrick et al., "Frontier Observatory for Research in Geothermal Energy: A Roadmap" (IDA Science and Technology Policy Institute, February 2019), https://www.ida.org/idamedia/Corporate/Files/Publications/STPIPubs/2019/D-10474.pdf.
8. DOE, "FY 2021 Congressional Budget Justification" Volume 3 Part 1, 145–153

ACKNOWLEDGMENTS

The authors wish to thank David M. Hart for providing input to this report. Any errors or omissions are the authors' alone.

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