U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

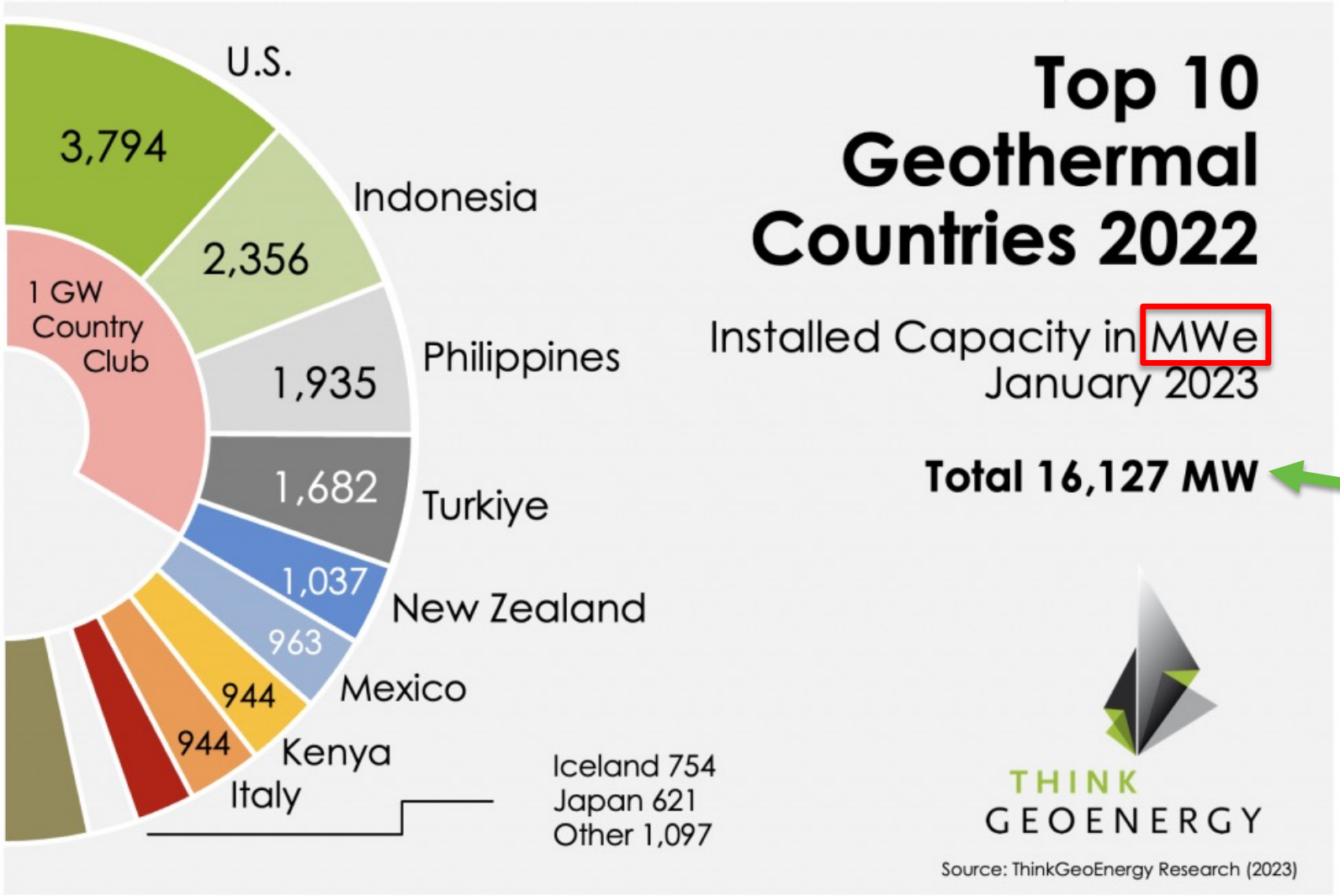
Geothermal Energy:

Solutions for a Sustainable Energy Future

Sean Porse, U.S. Department of Energy

Data, Modeling, and Analysis Program Manager, Geothermal Technologies Office

Global Geothermal Deployment



As of year-end 2022:

Represents an increase of 286 MW over 2021

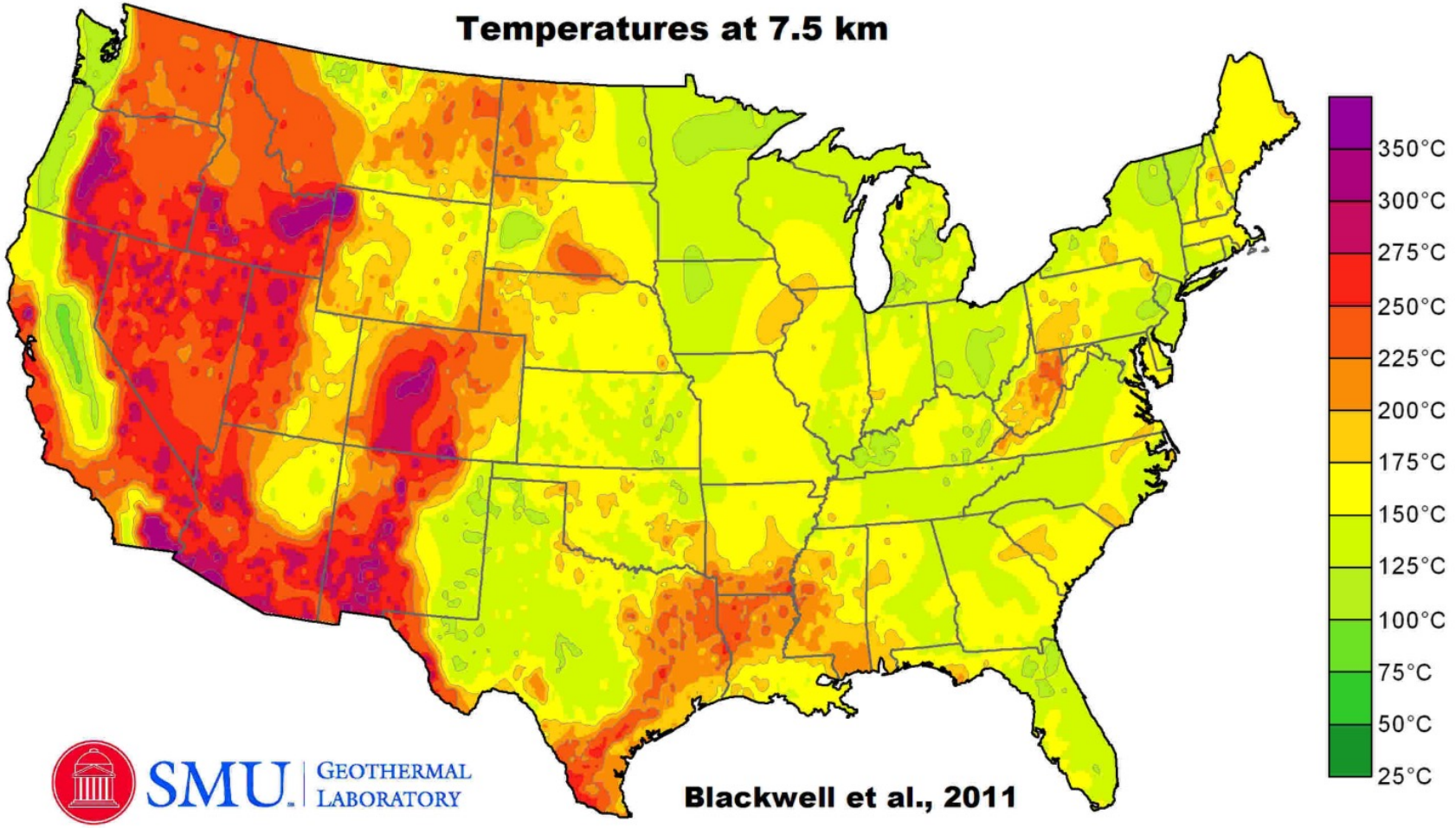
thinkgeoenergy.com/thinkgeoenergys-top-10-geothermal-countries-2022-power-generation-capacity-mw/

U.S. Geothermal Deployment: Power

Geothermal nameplate capacity by U.S. state

2021 U.S. Geothermal Power Production and District Heating Market Report: nrel.gov/docs/fy21osti/78291.pdf

U.S. Geothermal Potential: Power



Temperatures at 7.5-km depth

Blackwell (2011)

Southern Methodist University Temperature-at-Depth Maps
smu.edu/Dedman/Academics/Departments/Earth-Sciences/Research/GeothermalLab/DataMaps/TemperatureMaps

GTO's Multi-Year Program Plan: Six Research Areas

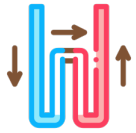
RESEARCH AREA	TECHNICAL OBJECTIVES
EXPLORATION AND CHARACTERIZATION	Improve resource targeting for all geothermal resource types
SUBSURFACE ACCESSIBILITY	Improve drilling costs toward the "ideal" cost curves used in the *GeoVision* analysis
SUBSURFACE ENHANCEMENT AND SUSTAINABILITY	Enhance and sustain geothermal energy recovery
RESOURCE MAXIMIZATION	Accurately capture the value of geothermal energy resources
DATA, MODELING, AND ANALYSIS	Expand the capabilities of using data to identify and address barriers to geothermal deployment
GEOTHERMAL INTEGRATION AND AWARENESS	Expand stakeholder education and outreach to improve understanding of geothermal energy and advance geothermal technologies

GTO's Program Areas

GTO aims to increase geothermal energy deployment through research, development, and demonstration of innovative technologies that enhance exploration and production.

Enhanced Geothermal Systems

Hydrothermal Resources



Low-Temperature and Coproduced Resources

Data, Modeling, and Analysis

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ENERGY earthshots
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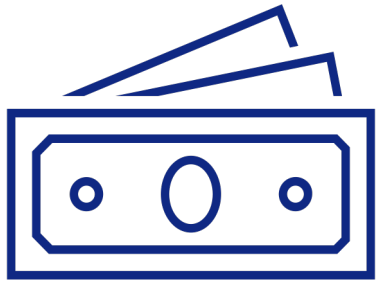
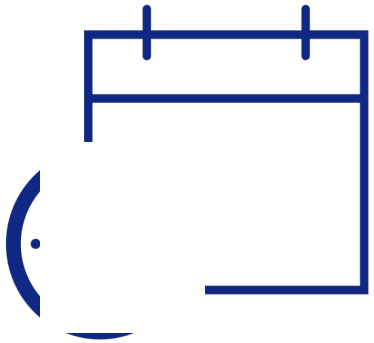
Enhanced Geothermal



$ 45/MWh



2035

Enhanced Geothermal Shot Analysis for the Geothermal Technologies Office

Chad Augustine, Sarah Fisher, Jonathan Ho, Ian Warren, and Erik Witter

National Renewable Energy Laboratory

nrel.gov/docs/fy23osti/84822.pdf

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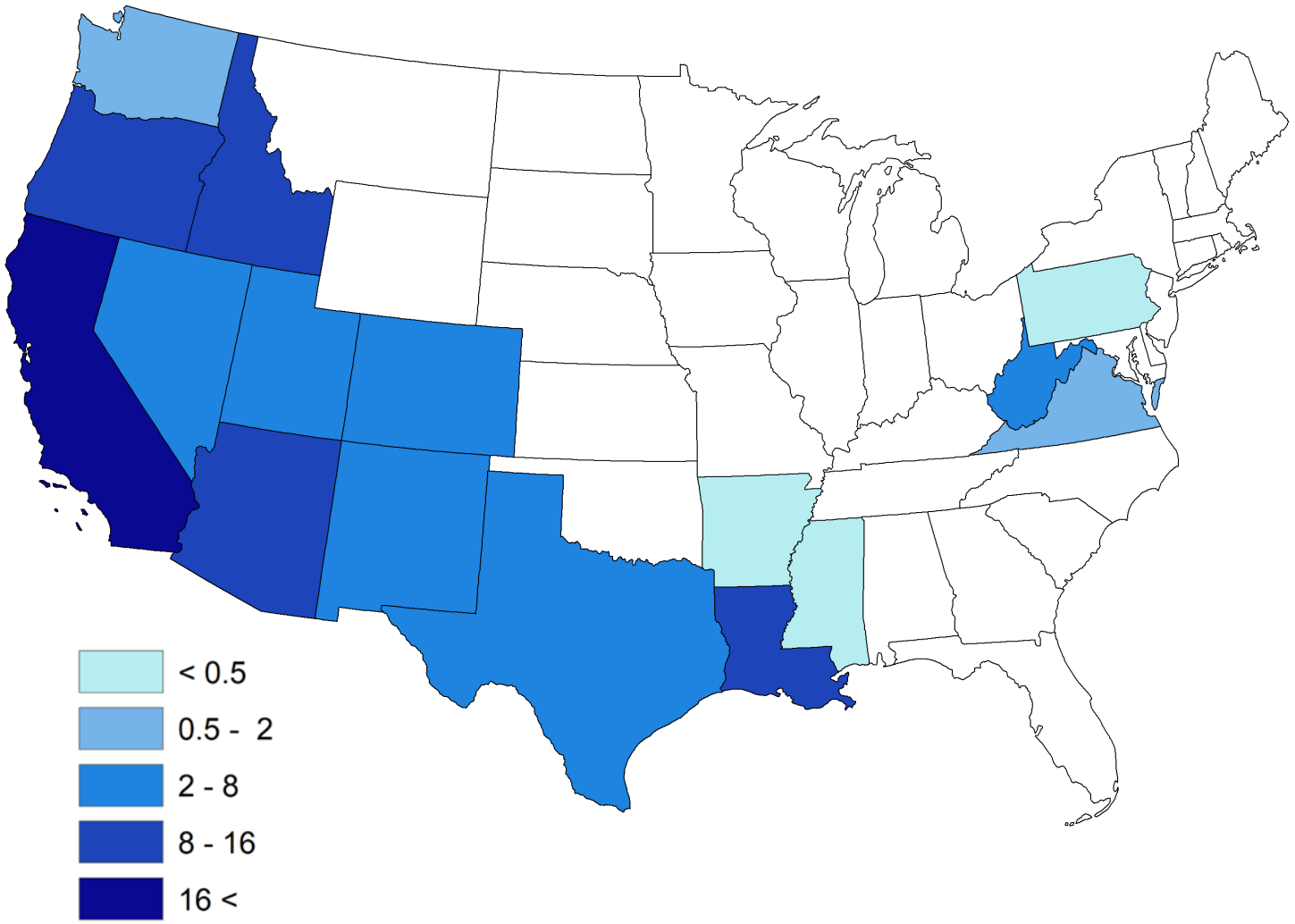
Enhanced Geothermal Shot

2050 Deep EGS Deployment Capacity (GW)



90 GW_e by 2050

- Expansion of geothermal for electricity generation
- Clean heating & cooling for U.S. households
- Drives just transition and leverages fossil workers

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Enhanced Geothermal Systems Pilot Demonstrations

Bipartisan Infrastructure Law, SEC. 41007

Topic 1: EGS Proximal Demonstrations: EGS demonstrations utilizing existing infrastructure proximal to existing geothermal/hydrothermal development with immediate potential for electrical power production.

Topic 2: EGS Green Field Demonstrations: Sites with no existing geothermal development and potential for shallow sedimentary, igneous and/or mixed metamorphic rock EGS with near-term electrical power production potential.

Topic 3: Super-hot / Supercritical EGS Demonstrations: Super-hot/ Supercritical EGS demonstrations located at well-characterized sites with near-term electrical power production potential.

Topic 4: Eastern U.S. EGS Demonstrations: Demonstration at a well-characterized eastern U.S. site, with existing wells in place and near-term electrical power/heat production potential.

EGS Enhanced Geothermal Systems
PILOT DEMONSTRATIONS

Frontier Observatory for Research in Geothermal Energy (FORGE)

- Frontier Observatory for Research in Geothermal Energy (FORGE) in Utah, GTO's largest funding initiative, is enabled by $200 million+ in federal investment and decades of public and private research.
  - Dedicated site where scientists and engineers can develop, test, and accelerate breakthroughs in EGS technologies and techniques.
  - Several notable successes, including:
    - Being one of the best-characterized geothermal sites in the world
    - Drilling six wells, including 1st-of-its-kind highly deviated well in hard/hot granite
    - Fastest drilling of hard hot granitic rock to date
    - Successfully conducting three-stage reservoir stimulation with *in situ* seismic monitoring.

UTAH FORGE
U.S. Department of Energy

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Other EGS Highlights

ReAmplify is providing $8.4 million to establish the commercial viability of geothermal energy production in existing oil and gas wells.

energy.gov/eere/geothermal/wells-opportunity-reamplify

Four ReAmplify projects selected in 2022:

- Geothermix, LLC (Texas)
- University of Oklahoma (Oklahoma)
- Transitional Energy (Nevada)
- ICE Thermal Harvesting (California)

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GEODE

Geothermal Energy from Oil and gas Demonstrated Engineering

GEODE will establish a consortium to leverage oil & gas subsurface assets, technologies, and expertise to help solve geothermal energy's toughest challenges, while providing clean energy employment opportunities and environmental benefits for communities.

Drilling Demonstrations Campaign

- Will reduce the cost of developing geothermal energy by generating at least a 25% improvement in geothermal drilling rates

- Two projects selected:
  - **Geothermal Limitless Approach to Drilling Efficiencies (GLADE)** (Denver-Julesburg Basin, Colorado)
  - **Evaluation of Physics-Based Drilling and Alternative Bit Design** (The Geysers Geothermal Field, California)

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Community-Scale Geothermal

Community Geothermal Heating and Cooling Design and Deployment initiative will help communities:

- Reduce energy burden and fossil fuel dependence
- Increase grid resilience & stability
- Improve environmental quality
- Support jobs

Eligible Projects:

- direct use
- heat pumps
- innovative designs & technologies

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Federal Geothermal Partnerships

- GTO and the Federal Energy Management Program are partnering with federal facilities to consider low-temperature geothermal technology to heat and cool installations.
  - Technologies include geothermal heat pumps, district and community heating and cooling systems, and hybrid systems that include geothermal resources.
- Oak Ridge National Laboratory and its partners will develop a technical assistance framework and workflow aimed at a deployment-ready report, supporting the deployment of geothermal energy at federal sites.

Identify federal sites that are strong candidates for geothermal heating and cooling technologies

Provide technical assistance for site characterization/resource confirmation activities at these sites

Break ground for multiple innovative geothermal system deployments

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Thank You!

the drill down

Get the hottest geothermal news from *The Drill Down*, GTO's monthly newsletter!

Sign up today: geothermal.energy.gov

Send questions or comments to:

doe.geothermal@ee.doe.gov

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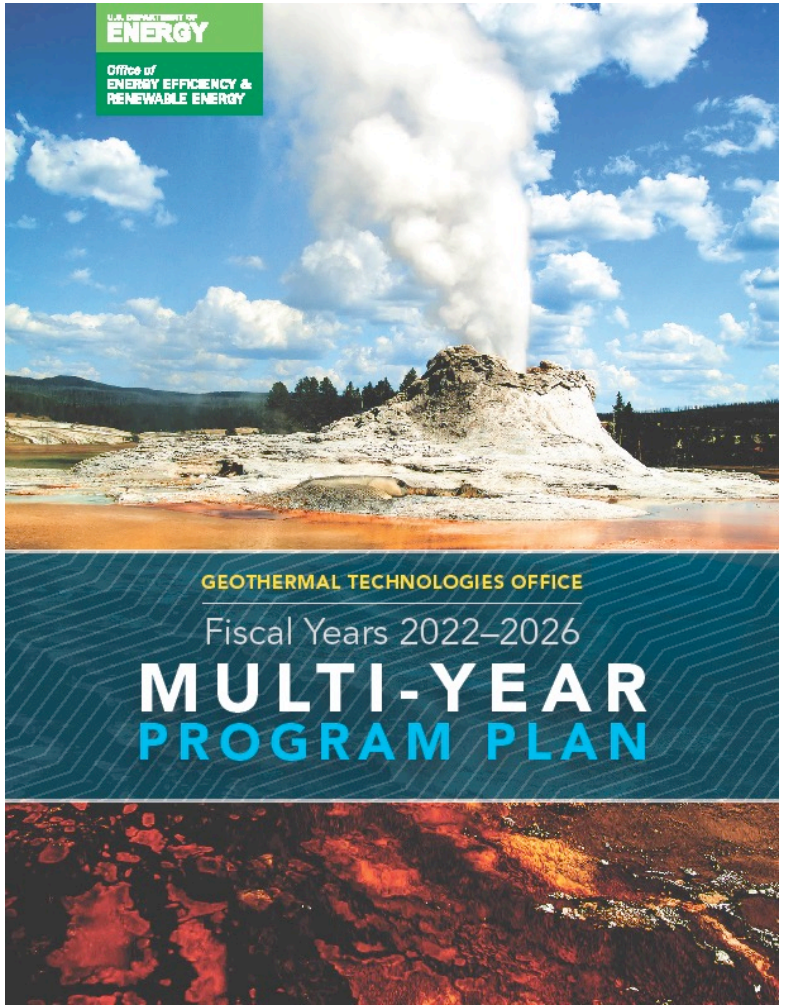
Back Up

5-Year Strategy for the Geothermal Technologies Office

GTO's strategic goals are for geothermal energy to contribute to the United States' clean energy future by:

- ✓ Providing generation for a carbon-free electricity grid
- ✓ Decarbonizing the U.S. building stock through direct-use applications, district heating and cooling, and geothermal heat pumps
- ✓ Helping to deliver economic, environmental, and social justice advancements.



https://bit.ly/GTOMYPP

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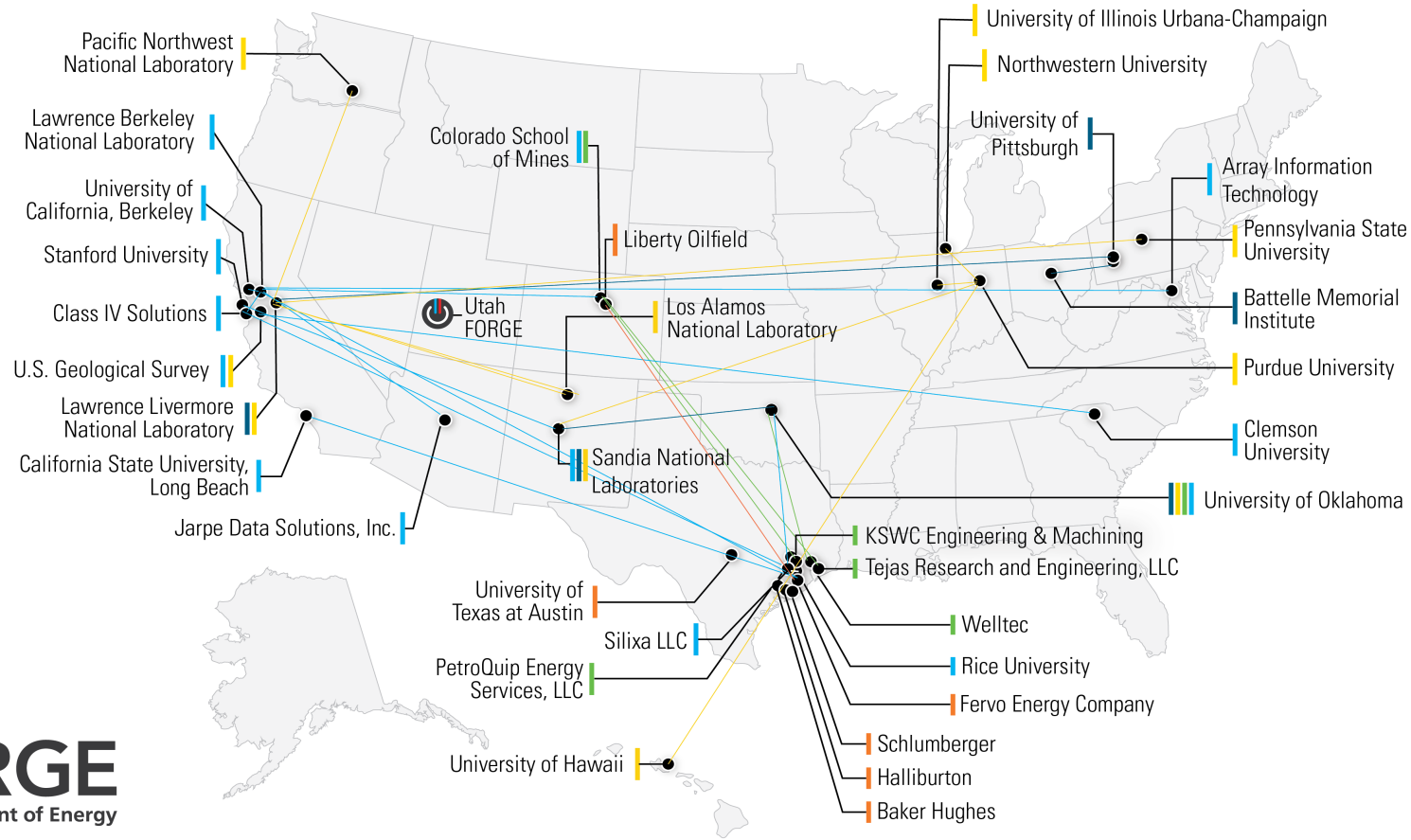
- FORGE's **first portfolio** of R&I projects supports 17 projects nationwide, with total fundin of $49 million (over 3 years).

- FORGE's **second solicitation** (currently open) will fund as many as 17 projects a total c up to $44 million for projects to advance EGS.

Utah FORGE 2022 R&D Partnerships



FORGE
U.S. Department of Energy

Topic 1	Topic 2	Topic 3	Topic 4	Topic 5
Devices suitable for isolating zones of a well at temperatures greater than 225°	Estimation of stress parameters	Field-scale characterization of reservoir stimulation and evolution over time, including thermal, hydrological, mechanical, and chemical effects	Stimulation and configuration of the wells at Utah FORGE	Integrated laboratory and modeling Studies of the interactions among thermal, hydrologic, mechanical, and chemical processes